Sewage Disposal of Los Angeles.

Report of Engineers

Regarding the

Disposal of Sewage

of the

City of Los Angeles

California

Contents

Published by the
Los Angeles Sewage Disposal Committee
October, 1921

Book No. 2

mac

Introduction

After the publication in March, 1921, of the Reference Book for the proposed North Outfall Sewer for the City of Los Angeles, arrangements were made by the City Council to obtain a report from the best sanitary engineers available, as it became apparent that the opposition to the proposed outfall sewer required as much enlightenment on the subject of sewage disposal as could be obtained from the highest authorities. Mr. George W. Fuller, of New York City, Professor George C. Whipple, of Harvard University, Cambridge, Mass., and Mr. William Mulholland, Chief Engineer of the Los Angeles Water Department, were selected by the Council as a Special Sewage Disposal Commission. The two first mentioned are eminent sanitary engineers of national reputation, and Mr. Mulholland is well known as the builder of the Los Angeles aqueduct.

This Commission made a very thorough examination of the situation in Los Angeles in April, and submitted the first two parts of its report to the Los Angeles City Council on April 16, 1921. As, however, more data was required by the Commission, the City Engineer, working under its direction, obtained considerable additional information, which was sent east for its use. The Commission further requested that Major John A. Griffin, City Engineer, and Mr. W. T. Knowlton, Engineer of Sewers, meet them in New York in May and assist in the preparation of their final report. This meeting, however, was delayed until the middle of July.

The report of the City Engineer of January 17, 1921, recommending the North Outfall Sewer, gave the amount of $12,850,000 as the estimated cost of the work, which included the construction of a sewage treatment plant at Hyperion. In the first part of its report the Special Sewage Commission recommended that the proposed Bond Issue be increased to $14,000,000 to provide for improvements at the end of the existing sewer outfall at Hyperion, to insure the outfall sewer being, as far as possible, acid proof, and to enable a start at once on sewage treatment and utilization. The Council, however, in apportioning the different amounts to the various projects which were to be submitted for a Bond Issue election on June 7, cut the amount proposed for the outfall sewer to $12,250,000. On June 7 the election was held and the Sewer Bond Issue was defeated. Only 38% of the total votes cast were in favor of the issue, whereas 67% was required to successfully carry the bond election.

This defeat made it necessary to submit an alternative plan to provide for the relief of the present overtaxed outfall sewer, and on June 23d the City Engineer submitted a report to the Council outlining such a plan, which is given in full in this publication. In this report of June 23d the City Engineer recommended that the Council at once have him confer with the Eastern members of the Special Sewage Commission, and also investigate the later developments of the sewage disposal plants in Eastern cities. This request was granted by the Council, and Major Griffin, accompanied by Mr. Knowlton, made an inspection of the sewage disposal plants in a large number of the Eastern cities. Soon after his return, the City Engineer submitted on August 27th, a report of the sanitary conditions found in the East. This report in a general way confirmed the plan he proposed on June 23d, making a few changes and giving a total estimate of $3,450,000 as the amount required for a bond election for sewage treatment and disposal. It should be thoroughly understood that this amount will provide for the treatment of only the present flow in the outfall sewer and that at the end of three or four years an additional bond issue will be needed to take care of the excess sewage,

which unless provided for will again cause the outfall sewer to overflow. If, however, the results attained by the construction of sewage treatment plants during the next three or four years are not successful, an ocean outfall can be built at a minimum expense.

In the following pages is given the above mentioned reports of the City Engineer for June 23d and August 27th; also the complete report of the conditions he found on the Eastern trip which should be of especial interest on account of the numerous photographs. An abstract of the report of Mr. Knowlton, concerning the North Outfall Sewer, taken from the Annual Report of the City Engineer for the past fiscal year, is also given. It is intended that the complete report of the Special Sewage Disposal Commission will be published as soon as the final report from this Commission has been submitted to the Council. It is to be hoped that the voters of Los Angeles, with these two publications on the disposal of sewage of Los Angeles at hand, will be sufficiently enlightened to comprehend the seriousness of the situation.

Report of City Engineer to Council

June 23, 1921

Office of the City Engineer, Los Angeles, California, June 23, 1921.

To the Honorable Council of the City of Los Angeles:

Gentlemen:

I beg to again call your attention to the condition of the outfall sewer, the flow in which is increasing at such a rate that, unless some relief is provided in the near future, the outfall sewer will probably be under pressure during most of the day, and will in the middle of the day overflow onto the ground adjoining it in certain portions of the southwestern part of the city before the end of the next two years. On account of the recent defeat of the bond issue for a new outfall sewer, it is necessary to immediately consider the next alternative plan of relieving this overtaxed condition. Even though it will ultimately cost more, its initial expense is about one-third of the outfall sewer cost. This plan consists of having a treatment plant installed near the southeastern portion of the city, where all of the sewage from the main sewer which now crosses the Los Angeles river at Boyle Avenue could be diverted and treated by the activated sludge process. This plan would be in accord with the recommendations of the Special Sewage Commission employed last March by your Honorable Body to report on the matter of sewage treatment and disposal for Los Angeles. As the amount of sewage which would be so intercepted and treated at this plant at the present time would not exceed 1,000,000 gallons per day, I have considered that a similar process of treatment could be installed at another plant to be built in the southwestern portion of the city, where, at the present time, approximately 10,500,000 gallons of sewage could be diverted through an intercepting sewer from the outfall sewer and treated.

By the removal of this total flow of 11,500,000 gallons per day from the outfall sewer, it would be temporarily relieved, at least for 18 months, and I have estimated that to divert and treat a total flow of 31,000,000 gallons of sewage per day, the outfall sewer could be relieved for a period of about three years. If, in the meantime, the results obtained by this treatment should prove satisfactory, other units could be added to the plants at each of these locations as required, which would prevent the outfall sewer from again becoming overtaxed, providing subsequent bond issues are voted. The cost

of the necessary diverting sewers required at the present time to take sewage to the proposed treatment plants, together with the cost of units required at said plants for the treatment of 31,000,000 gallons per day, is estimated at approximately $3,250,000. In addition thereto, a sufficient amount should be allowed to pay for the maintenance and operation of the units required for these treatments plants. As the discharge from the end of the present outfall sewer would not be treated by either of these proposed plants, it would be necessary to install either a screening plant or still another activated sludge plant at Hyperion to remove the cause of complaint of the residents of the beach cities on the west coast. The cost of this screening or treatment should be included with the above costs, making a total of approximately $4,150,000, which would be the approximate amount of a bond issue required at this time. These costs, however, to be better determined after a thorough investigation of all the principal eastern plants.

If this plan for relieving the outfall sewer should be adopted, rather than the construction of the proposed outfall sewer, subsequent bond issues would be required to pay for the cost of additional activated sludge treatment units of sufficient capacity to prevent the outfall sewer from becoming overtaxed, after the increased discharge of sewage from the ever-growing city had reached the maximum flow which could be treated by the plant units installed by the proposed bond issue of approximately $4,150,000, and by subsequent bond issues.

As shown in my report to your Honorable Body of June 6, 1921, the installation and operation of such treatment plants would prove much more costly to the tax payers of the city of Los Angeles at the end of the thirty-year period, for which the proposed outfall sewer was planned, than would the proposed outfall. This statement is borne out by preliminary estimates of costs I have prepared, which show the amount of money required to be obtained at different intervals (by bond issues) to treat the excess sewage which would overtax the outfall sewer and which must be cared for. These estimates also show that a large deficit would occur annually which will render the project unpracticable from the viewpoint of the financial condition of the City of Los Angeles.

In order, however, that an extended study of this matter may be obtained, I recommend that I be authorized by your Honorable Body to visit and investigate the different plants of the activated sludge type which have been installed in other cities in the eastern and central portions of the country. Such a study is necessary if I am to prepare plans for such units to be built and operated at a minimum cost, and is in accord with the request of the Special Sewage Commission.

The accompanying map shows the general location of the plants which could be installed; also the proposed outfall sewer, which was planned to provide for the removal of sewage from two of the large sections of a general metropolitan sewerage district, i. e., the central and northern sections. In connection with the plans prepared for a new outfall sewer, I gave much study to the subject of a future metropolitan sewerage district, the north and central sections of which must be provided for at the present time. At some future time, when it becomes necessary to provide for the removal of sewage from that portion of the metropolitan district designated on the maps as the northeast section, which lies between the easterly boundary of the City of Los Angeles and the San Gabriel River, and extends from the mountains southerly to a line along that portion of the Santa Fe Railway which is located between the southeast corner of the city and Los Nietos, an outfall sewer can be planned which will remove the sewage from this section and treat it at some location near the southerly boundary of the section, or carry

it, by an extention of the outfall for this section, southerly along the line of the Los Angeles river to the ocean on the south coast. Sewage from the so-called south section of the metropolitan sewerage district, which is located south of Manchester Avenue and the portion of the Santa Fe Railway above described, could be intercepted by laterals draining into such a proposed outfall sewer.

With reference to the beach sections shown on the accompanying map, I have considered that local treatment of the sewage of the several cities in these sections can be planned at different locations on the west and south coasts, although it is believed that the sewage of the cities on the west coast can best be collected at Hyperion, as I have reported at various times during the past.

Since the filing of the first portions of the report of the Special Sewage Commission, I have furnished the Eastern members of this Commission certain data they have requested for the purpose of preparing their final report, and, in connection with this final report, I beg to advise that these engineers have requested that I arrange to meet them in the East, for the purpose of conferring in regard to the details of their proposed plans for the installation and operation of the activated sludge treatment plants herein suggested.

I recommend that I be instructed by your Honorable Body to proceed forthwith and investigate the latest developments at the principal eastern plants and present to you, at the earliest date possible, complete plans, with estimates, that a bond issue may be called at an early date.

(No. 78742—J..A.G.)

Respectfully submitted,

JOHN A. GRIFFIN,
City Engineer.

Copy of Report regarding North Outfall Sewer taken from Annual Report of City Engineer for year ending June 30, 1921

NORTH OUTFALL SEWER

1.—Preliminary Work

At the beginning of the past fiscal year studies were made and reports prepared showing the need of a new outfall sewer. These studies indicated that such a new outfall would be required within a few years, as the amount of sewage discharged into the present outfall sewer was increasing so rapidly that the present outfall would probably become overtaxed before 1924. Furthermore, the rapid increase of new buildings west of the present sewered area of the City has indicated that some provision must be made in the near future for an outfall sewer which would render unnecessary the use of cesspools for all of the district lying between Rimpau Avenue and the cities on the west coast. At the present time a portion of this non-sewered section is not included within the City boundaries, but plans for the annexation of such portions are being made, and it is probable that an outfall sewer for this district will be needed before such an outfall can be completed.

In addition to these reasons why a new outfall sewer is needed, the increase in the amount of sewage from the industrial district, which is located along the Los Angeles River, has been so great during the past few years that the capacity of that portion of the central interceptor sewer, which is

located on the east side of the Los Angeles River, north of Sixth Street, is becoming over-taxed.

The need of this new outfall sewer has been referred to in special reports of this department and in almost every annual report since June 30, 1912. As the continued increase in the flow in the present outfall sewer has been carefully noted from year to year, it became apparent over a year ago that the matter of rights of way for a new outfall sewer should be secured, and to provide for this part of the work an appropriation of $5,000.00 was made by the Council at the beginning of this fiscal year. This amount will pay for a portion of the right of way required for this improvement, but it is probable that an additional amount must be provided before all of the deeds required for the right of way can be obtained.

2.—Proposed Plans

Preliminary plans for this new outfall sewer were completed and reports to the Board of Public Works and City Council were submitted in September and November of 1920, also in January, 1921, giving in detail the conditions and reasons why such an outfall sewer was required, and recommending that the matter be submitted to the vote of the people for a bond issue at an early date. The first estimate of cost prepared for the proposed new outfall was approximately $12,200,000. Later, after further consideration to certain details concerning the design and construction of the sewer had been given, this amount was increased to $12,850,000.

On account of the large amount of money which would be required for this improvement it became apparent when the matter was submitted to the Board of Public Works and the City Council that an educational campaign would be required for the purpose of showing the public the facts as to the need of such an improvement. Furthermore, to have the matter examined and checked by other engineers than the City Engineer, a committee of six local engineers was selected by representatives of prominent civic organizations of the City. This Advisory Board of Engineers, after a careful examination of the plans, reported, after a study of two months, that with a few corrections the plans prepared by the City Engineer were sufficient for the work required.

In making the necessary studies and preliminary plans for this new outfall sewer, attention was given to the growth of the different sections of the City and the work, as proposed, was planned to provide for the increased growth of Los Angeles and the probable conditions which would exist in 1950. The design of the new outfall sewer provided for a general metropolitan district, and for the extension of the City to the west and north, so that all the area lying west of the easterly boundary line of the City of Los Angeles, north of Manchester Avenue, and south of the northerly boundary line of the San Fernando Valley, would be benefited by the proposed improvement. This area would include all of the land lying between the west coast and the mountains to the north of the San Fernando Valley, Burbank, Glendale and Eagle Rock, with the exception of the beach cities, sewage disposal for which cities can be provided if necessary within their own limits, or by treatment at Hyperion. In the report of the Advisory Board of Engineers special attention is called to the areas which would in the future be contributary to the proposed sewer, which areas are included in the Los Angeles Metropolitan Sewerage District, for which the proposed outfall sewer was planned.

3.—Sewage Treatment

In addition to the plans prepared for the new outfall sewer, studies have been made for the treatment and disposal of the sewage at the ocean. This

part of the proposed improvement has been given considerable attention, examinations being made of sewage treatment plants in various portions of the state, as well as noting the type of treatment described in reports of other cities. After making such studies, the use of a fine screening plant was recommended for the treatment of the raw sewage at Hyperion, recommendations for which plant with a report on the use of such screens were also given in the annual report of this department for the year ending June 30th, 1920.

4.—Land Disposal

After the plans for the proposed outfall sewer were submitted to the Board of Advisory Engineers, it was found that some opposition to the project arose from persons who objected to the discharge of sewage into the ocean, these persons believing that the City was wasting certain values which might permit a profit to be recovered by the City if the sewage should be treated and then disposed of onto the land through irrigation ditches. In order that such plans might be given careful consideration, detailed studies of the disposal of sewage on land were made. Before the flow in outfall sewers can be used on land, however, it is considered by all that necessary treatment must be given to the flow which would render the sewage free from offense if used for irrigation. Although there are three or four types of treatment which can be considered for this purpose, it was considered that the best form of treatment which could be used was that of the activated sludge process, which renders the effluent practically free from bacteria and produces a sludge that can be dried and used for fertilizing purposes. Studies for the installation of such treatment plants were accordingly prepared and estimates of costs obtained of the different factors required for such a treatment.

The land to the south and southeast of the city, on which treated sewage effluent could be discharged, would require long distributing conduits, even under the most favorable conditions. Studies for the land disposal of sewage included the planning of sewage treatment plants along the line of the outfall sewers and it was considered that a certain length of new collecting sewers would be required to bring the sewage to such treatment plants. In some cases resort to pumping the sewage would be required, as the land on which disposal was to be made was in some places several feet higher than the sewer.

In some of the discussions that have occurred during the past year, proponents for the land disposal of the sewage have considered only certain portions of the cost required therefor. To properly consider the entire cost, one must allow for the item of collecting sewers required, pumping when necessary, the installation and operation of the treatment plants, and the installation and maintenance of the distributing conduits therefrom.

As a result of the studies for land disposal, it was found that the present available acreage for such a disposal was sufficient for the present volume of sewage now discharged into the ocean at Hyperion, but that as this volume increased to an amount which would probably be carried by outfall sewers in the future, the land for such a disposal was not obtainable in Los Angeles County. Studies and inquiries made as to whether such land was available in Orange County gave no encouragement to this method of disposal. If, however, the land now available for land disposal of sewage was sufficient in area, it was found that the cost required for the different steps of the process of collecting, treating and distributing the sewage would be more than the probable income to be derived by the sale of the water and solid matter which could be used for fertilizer.

5.—Ocean Disposal

In contrast to this method of disposal, studies made of the discharge of treated, screened sewage into the ocean at Hyperion indicated that all of the solid and floating matter would be removed and that the effluent from such screening plants would receive such further treatment from the oxygen in the ocean that the amount of bacteria at a distance of one-half mile or more from the point of discharge would be no more than is found along those beaches which are not affected by even remote outfall sewers. It was, accordingly, considered that the screening proposed at Hyperion, together with the oxidizing effect of the ocean, will remove all objections now made by the residents of the beaches on the west coast. In this connection reference should be made to the presence of oil which is found on the west coast beaches as not necessarily coming from the Los Angeles outfall sewer, but probably from the oil well off the coast at Redondo and from other sources.

6.—Opposition to Sewer Bond Issue

During the months from February to May, inclusive, of this year, the opposition to the proposed sewer bond issue became more pronounced as time went by, and counter-proposals were made by some individuals and organizations, which, supported by the daily press, had the effect of misleading the public. Such proposals referred to the possibility of installing plants where the sewage would be treated by the activated sludge process and also to the construction of a smaller outfall sewer which, it was thought by the proponents, might suffice for a period of ten years. In this connection, reference to the cost of the present outfall sewer was made, as it was thought by the proponents of such a smaller sewer that a duplication of the present outfall sewer could be constructed at a cost of not over $2,000,000, and that this improvement would be sufficient for the next ten years. Other opposition to the proposed sewer bonds was made by those who had for sale certain processes of sewage treatment which they considered would cause the sewage to be so treated that the solid could be recovered and sold at a price which they thought would more than offset the cost of treatment.

Regarding these different alternate methods of treatment and disposal, an earnest endeavor has been made to investigate carefully the details of each plan proposed, in order that if the alternate plan should be found feasible, its costs could be considered. As, however, in almost every case it has been found that the process of sewage treatment proposed by such alternate plans has not been given a trial on any municipal working basis, it is not thought that such alternate plans should be considered in contrast with the proposed sewer outfall or the activated sludge treatment until a more detailed investigation covering the installation and operation on a large scale can be made. Furthermore, it may be noted from the report of the Special Sewage Disposal Commission, which was appointed by the City Council in March, that allowing for the average operating cost of $10.00 per million gallons, with an additional cost of $15.00 per ton for pressing and drying the sludge, the city would lose $1,490,000 annually if the activated sludge method of treatment were adopted for the probable amount of sewage which will come from a population of about 2,500,000 in 1950.

7.—Special Sewage Commission

This loss has been computed from the estimates given in the report of the consulting engineers of this commission, who considered that the activated sludge process would produce about one and one-half tons of fertilizer per million gallons and that this fertilizer would contain about four units of organic nitrogen, which would have a value at the plant of $18.00 per ton.

This loss would be increased if allowance were made for the cost of the necessary collecting sewers and for the disposal of the effluent from the plant. On account of the amount of grease and mineral oil contained in the Los Angeles sewage, these engineers reported that the **commercial success of the sludge utilization project would be uncertain.**

The assistance of this commission was considered necessary, as the large amount of money required for a new outfall sewer was reaching practically the non-revenue producing bond limit, and opinions of the best sewage experts were requested by the public. In order that the selection of members of this commission should be properly obtained, the local chapters of the American Society of Civil Engineers and of the American Association of Engineers requested the secretary of each of these national engineering organizations to send to the City Council the names of several prominent sanitary engineers who were qualified to act on such a commission. Upon the receipt of the names of such experts, the City Council, with the assistance of Mr. William Mulholland, who was selected as a member of this commission by the Council, chose the names of George W. Fuller, of New York City, and Professor George C. Whipple, of Harvard University, in Cambridge, Mass., to act as members of this commission. Accepting the choice made by the Council, the eastern engineers arrived in Los Angeles on April 4, and after two weeks' careful study of the conditions on the ground, prepared the first part of their report on the matter of sewage disposal for the city. Previous to the departure of these eastern engineers on April 16, this part of the report of this commission was filed with the Council which gave their findings, conclusions and recommendations. This report, copies of which are on file with the City Clerk, covers the general situation which applies to the Los Angeles conditions, but it does not complete the work for which the commission was appointed, as these engineers deemed it necessary to make a thorough study of other findings which have been obtained by this department for their use. At the time of their departure it was thought that the final report of the commission would be prepared and submitted before the end of this fiscal year, but on account of the time and amount of work required for the securing of the data requested by these engineers, their final report has not as yet been prepared.

8.—New Outfall Sewer Demand

It will be noted, however, from the conclusions published by this commission in the first part of their report, that a **new ocean outfall should be constructed as soon as possible,** in which conclusion the writer must emphatically concur. A careful, systematic record of the daily flow of sewage in the outfall sewer indicated that the present outfall sewer is carrying its maximum capacity during the middle portion of the day at the present time, and that this condition will probably occur during all of the day before the end of 1923, at which time it is probable that the amount of sewage discharged into the outfall sewer will so overtax this conduit that sewage will be forced out of the manhole tops on to the adjacent ground. Unless relief measures to intercept the increasing flow of sewage can be carried into effect before the next rainy season, it is possible that the city may be served with injunction suits for the damage to private property from the overflowing sewage. Such a condition seems almost inconceivable for a city of the size and importance of Los Angeles, but until the opponents to the proposed outfall sewer can realize that this proposed improvement, although very costly, is the cheapest way for the disposal of the sewage of the City of Los Angeles, it appears that the proposed outfall sewer will be blocked indefinitely and the present outfall will become overtaxed and discharge the sewage which it can-

not carry on to lands in the southwestern part of the city. This condition will probably require the construction of ditches for the removal of the excess sewage unless funds for intercepting sewers which will carry the excess flow in the present outfall sewer to water courses can be obtained. The defeat of the sewer bond election on June 7, 1921, when funds amounting to $12,250,000 were proposed for the new outfall sewer and treatment at Hyperion is very regrettable, and makes necessary immediate steps be taken to provide a quick alternative, to prevent disaster.

Report of City Engineer to Council On August 27, 1921

Office of the City Engineer, Los Angeles, California, August 27, 1921.

To the Honorable Council, of the City of Los Angeles.

Gentlemen:

I beg to submit the following report of the inspection I have made of the sewage disposal plants in Eastern cities and of the sanitary conditions I found in those cities which I visited with Mr. W. T. Knowlton, Engineer of Sewers, during the months of July and August.

The inspection began at Milwaukee where a small experimental plant is now in operation, and their ultimate plant under construction.

No revenue of any nature is derived from their effluent or sludge, and while it is anticipated that when the big plant is finished some two years hence, the sludge will be reclaimed and sold, it is not anticipated that the revenue so derived will do any more than offset a portion of the cost of such reclamation.

The next principal stop was made in New York to attend a conference with Mr. George W. Fuller and Prof. Geo. C. Whipple, eastern experts of the Special Sewage Disposal Commission. At this conference I submitted my proposed plan of diverting the sewage to the two small treatment plants, which I had recommended to your Honorable Body prior to leaving here, and my recommendation was concurred in by them. While in New York side trips were made to Allentown, Pa. and Phillipsburg, N. J., and an inspection made of the Landreth Direct Oxidation Process at these points; also a trip to Plainfield, N. J. and New Britain, Conn., at which latter place a Dorrco screen was in use.

On arrival at Boston I was escorted over the Harbor to each of the sewage outlets by Mr. Harrison P. Eddy, together with several members of the Metropolitan Sewerage Commission and Water Works Department, and observed the effect of the multiple outlet distribution of the sewage field. The daily discharge of sewage into Boston Harbor is more than four times the total quantity carried by our present outfall sewer and receives no treatment whatsoever; the steamers entering and leaving Boston Harbor cross directly through the sewage field. Dependence for dilution and disposal is placed upon tides and salt water.

Inspection of the sewage plants in operation at Fitchburg and at Worcester were next made, after which Syracuse and Rochester were visited. Imhoff tanks and sprinkling filters are in constant use at both Fitchburg and Rochester, and Worcester is now building a similar treatment plant. At Syracuse an outfall sewer is under construction.

A visit to Cleveland permitted a good inspection of the Imhoff tanks being built and of the conditions along the bathing beaches which were near the sewer outlets. Detroit, Toledo and Lima were then seen, in all of which cities large sums are being spent for outfall and intercepting sewers. It was

next noted that the Imhoff tanks and sprinkling filters at Columbus gave satisfactory results, and that this plant was needed to prevent pollution of the Scioto River. At Indianapolis it was noted that a new outfall sewer was to be built and that considerable study was being given to the activated sludge treatment process.

We inspected at Chicago a large Imhoff tank plant under construction in the Calumet District; also visited testing plants where tannery and corn product wastes were being treated. Along the North Shore at Chicago an inspection was made of the sewer plants at Fort Sheridan and at the Great Lakes Naval Station. After leaving Chicago a visit was made to the State University of Illinois at Urbana, where an experimental sewage plant of the Dorr-Peck type is in operation. The return trip from Chicago to Los Angeles was made by way of New Orleans and Houston, at which latter place two activated sludge plants have been in use since 1918.

The total mileage covered by the trip amounts to approximately 8,500 miles, and covered an investigation of some 35 plants. The total expense, including railroad fares, etc., amounted to $1,152.45, and the balance of $347.55 has been returned to you.

In the following chapters I have given a condensed report of the sewer conditions in each of the cities I visited. From an examination of these conditions it will be noted that several of these cities have investigated the different methods of sewage treatment and disposal in use, and that the construction of intercepting and outfall sewers is required in most of these cities. Furthermore, the discharge of raw sewage into the ocean or into a large body of water is not infrequent, when sufficient dilution can be obtained and floating matter removed. To provide for dilution, the outlet end of the outfall sewer should be at a depth of about 25 to 30 feet, being that used in Boston, Syracuse and Cleveland. In only one or two of the cities visited was any use made of the sludge as a fertilizer, and in those cities the sludge value did not exceed $0.50 per cubic yard. On the contrary, the sludge from the sewage treatment plants is usually wasted or used for filling low land

A brief summary of the treatment of the sewage in the various cities visited would divide the cities into two general classes; first, those discharging their sewage into the ocean; and, second, the inland cities. Of the latter, the general plan used for treatment consist of a combination of settling tanks and filters, the only exception being the direct oxidation (Landreth) process and the activated sludge process. Where the sewage was discharged into the ocean, no treatment was required if the suspended matter was taken to sea by the tides.

In my report to your Honorable Body of June 23rd, I proposed as an emergency measure an alternative plan for relieving the over-taxed condition of the present outfall sewer of Los Angeles, and at the same time demonstrate the recovery theory by installing sewage treatment plants in or near the southeast and southwest sections of the City. These plants were proposed to be built in units having a total capacity of about 31,000,000 gallons per day, which would suffice to relieve the outfall sewer from overflow during the next three or four years. The cost of such plants, together with intercepting sewers required to carry sewage to the plants, was then estimated at $3,250,000. In addition to this cost, I proposed that a sufficient sum be allowed for the operation of these treatment plants, and that a screening plant be installed at Hyperion to remove all suspended matter from the ocean discharge. The total cost of these plants, including a sum sufficient for three years operation, was estimated at $4,150,000.

After a careful study of the situation in Los Angeles, following my inspection of the sewage disposal plants in the Eastern cities, I **recommend** that the

above plan be adopted with the following modification as relates to initial installation and paying for operation costs.

First: The construction of an intercepting sewer south of and adjacent to the so-called Air Line Railroad, extending from the junction of Arlington Avenue and Exposition Boulevard westerly to the vicinity of Moynier Lane and the Ballona Creek, which sewer will provide for the unsewered districts in the western part of the City between Exposition Boulevard and Hollywood and as far west as the junction of Washington Street and Adams Street; and also for the removal of the excess flow in the present outfall sewer, which is causing the trouble at the junction of Arlington Avenue and Exposition Boulevard. The cost of this item is estimated at $1,304,000.

Second: The installation of an activated sludge plant, to be known as the Southwest Sewage Treatment Plan, of 12,000,000 gallons daily capacity at a location near the westerly terminus of the intercepting sewer described in the first item, with provision for discharging the clarified effluent into the Ballona Creek. The cost of this item is estimated at $926,000.

Third: The installation of an activated sludge plant, to be known as the Southeast Sewage Treatment Plant, of 6,000,000 gallons daily capacity to be located on City property in the southeastern part of the City, with provision for discharging the clarified effluent into the Los Angeles River bed. The cost of this item is estimated at $488,100.

Fourth: The construction of an intercepting sewer to deliver sewage from the east side of the Los Angeles River to the Southeast plant described in the third item. The cost of this item is estimated at $397,600.

Fifth: The installation of a fine screening plant at Hyperion of 54,000,000 gallons daily capacity, which will remove the suspended matters from the flow of the present outfall sewer, the cost of which plant is estimated at $300,000.

Sixth: The extension of the ocean end of the present outfall sewer so as to discharge the screened sewage at the bottom of the ocean, the cost of which is estimated at $34,300.

The total amount of the foregoing six items is $3,450,000, for which I recommend a bond issue be submitted to the people at the earliest possible date.

In adopting the above program, it should be understood that during the installation of the items above recommended it may be necessary to deliver sewage from the present outfall onto certain areas which should be obtained for this purpose, such temporary disposal, however, to be considered purely as an emergency measure to prevent the overflow of sewage onto city streets, and built-up areas where construction is under way. Furthermore, it should be understood that the above plan will only provide for the removal of the excess flow in the outfall sewer for a period of three or four years and at the end of such period, extensions will have to be made by future bond issues, or if it is found by experience during this period that the results obtained do not warrant the extension of this method of disposal, a change to ocean outfall or other means can be made at a minimum of expense. The yearly cost of operation and maintenance of the treatment plants and screening plant above recommended is estimated at $258,300, for which arrangements must be provided in the annual budget of the City instead of by bond issue. While it is possible that some revenue may accrue from the sales of water and sludge, I have made no allowance for such sales, as such revenue is problematical.

On account of the great need of securing the earliest possible relief for the present outfall sewer and providing facilities for the ever-growing City, I recommend that your Honorable Body take early action in this matter.

Respectfully submitted,

(No. 78742—J. A. G.) JOHN A. GRIFFIN, City Engineer.

Sewage Disposal in Eastern Cities

(Accompanying report of City Engineer to Council on August 27, 1921.)

CHAPTER 1.

Milwaukee, Wis.

This City has a population of 500,000, which is 100 per cent sewered. The sewage is both industrial and domestic.

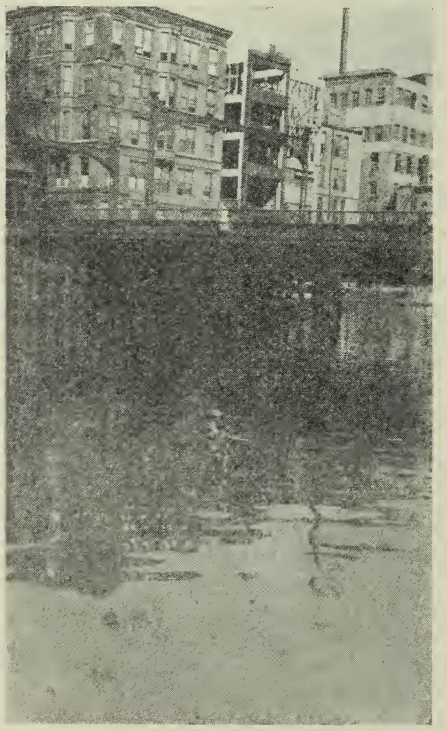
The average daily flow is 65,000,000 gallons; the minimum is 35,000,000 gallons and the maximum 80,000,000 gallons. Three-quarters of the total daily flow is discharged into the Kinnickinnic River and one-quarter into Lake Michigan. The use of the river for disposal of so much of the sewage has created such a nuisance that it has been necessary to pump 80,000,000 gallons of water per day from the lake into the river to dilute the sewage.

At the present time about 200,000 gallons of sewage flow into the lake is treated at the experimental station on Jones Island.

The sewage contains an average of 300 parts per million of suspended matter and has an average temperature of 52°, varying from 34° to 72°, the corresponding atmospheric temperature being 55°, —16° and 98°.

The sewerage system consists of a high and low level system, two-thirds of the total flow being in the high system and one-third in the low. Forty per cent of the sewage is pumped, while the balance is on a gravity basis.

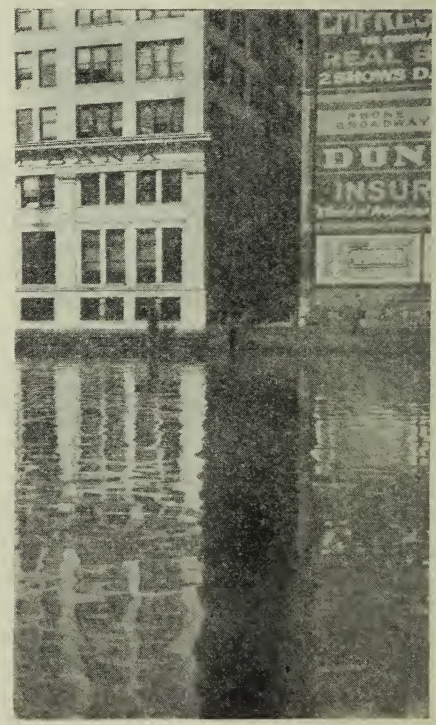
The intercepting sewers have a length of 35 miles, and were built of concrete in 1915 with only cement wash for a protection coat.



Two Views
Milwaukee River, Milwaukee

The final treatment plant was begun in June, 1921, and will be finished in about two years.

The experimental work was begun in 1915 and exhaustive research and



study has been carried on to date, costing $500,000. The 200,000 gallons now being treated daily at this plant passes through a grit chamber with a velocity between 0.64 and 1.0 feet per second, and then through fine screens, after which it is pumped to two aerating tanks in series, where it is subjected to a four-hour detention period at peak load in the day and eight-hour detention period at night.

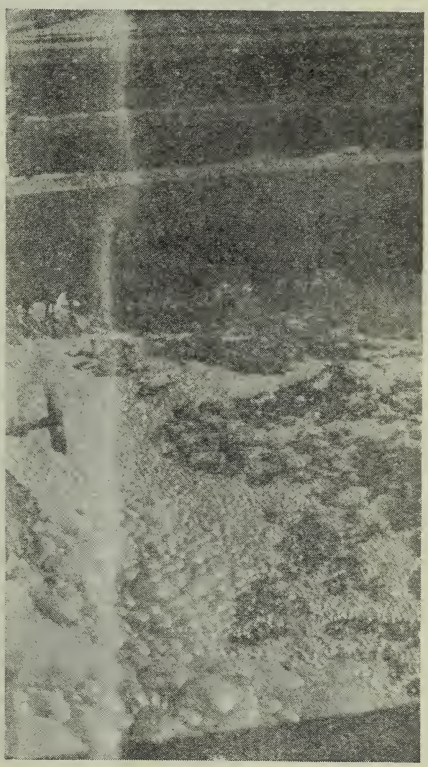
Grit Chambers, Milwaukee

The amount of air used at the present time averages 1½ cubic feet per gallon of sewage treated, has a pressure varying from 6.9 to 7.1 pounds per square inch, and this is diffused through filtros plates at a ratio of 1 to 4.4. In the new plant it is planned to reduce the air to 1.1 cubic feet per gallon treated.

From the aeration tanks the sewage flows over a weir to a settling chamber having a Dorr thickener. From the chamber the clarified effluent flows to the lake and 18% of the settled sludge is returned to the aerating tanks. The balance of the sludge is then pumped into a centrifuge dryer where the percentage of moisture is reduced from 98% to 82%. This machine is known as the Besco-Ter Meer Centrifuge and is sold by the Barth Engineering & Sanitation Co., 11 East Forty-eighth Street, New York City.

This machine now handles from eight to sixteen thousand gallons, or an average of 12,000 gallons of this returned sludge per day, or will produce from 9,000 to 10,000 pounds of 82% to 83% moisture cake per million gallons.

The total capacity of each of these machines varies from 40,000 gallons to 60,000 gallons of returned sludge per million gallons of sewage treated, or, in other words, it will require from 1 to 1½ machines per million gallons of sewage treated.



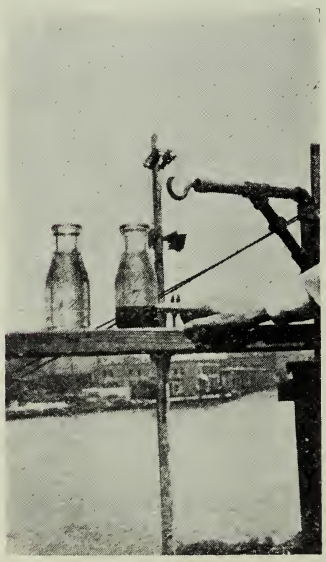
Activated Sludge Plant, Milwaukee

This machine operated on 15-minute to 20-minute intervals and produces approximately 100 pounds of cake 83% moisture every 15 to 20 minutes.

The present treatment plant was put into operation in October, 1920, and removes 90% of the suspended solids, 98%of the bacteria with an effluent of 72 hours stability. This stability would permit the effluent from either of our proposed plants to reach the ocean before becoming putrid, but will not prevent algae from growing along the canals.

To date no cost data is available except Mr. Hatton's estimates, i. e., initial installation at $55,000.00 per million gallons and $35.00 per million gallons operating cost.

Activated Sludge Plant, Milwaukee



ALLENTOWN, PA.

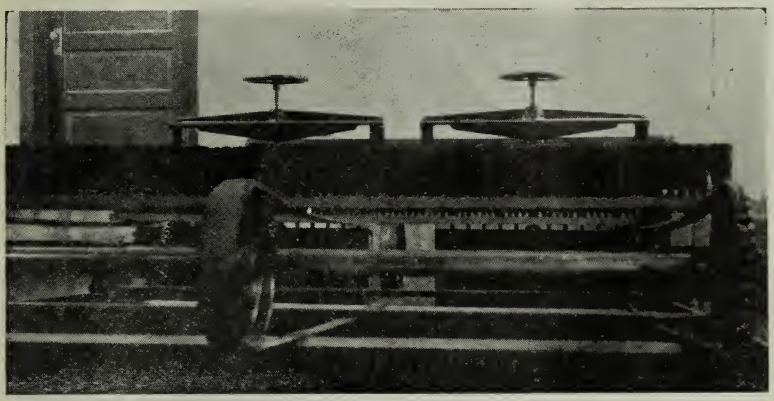
Chapter 2.

Allentown has a population of 85,000, 30,000 to be sewered by plant just completed as soon as the system can be installed.

The sewage is domestic with slight industrial waste. The average daily volume to be treated is estimated at 2,000,000 gallons, the maximum 3,000,000 gallons, and the minimum 1,500,000 gallons.

The plant is designed on the basis of 100 gallons per capita, and consists of three units of the Landreth Direct Oxidation Process each of 1,000,000 gallons capacity.

This type of treatment includes the use of a fine screen to remove all particles greater than ⅛" in diameter.



Traveling Brushes, Allentown

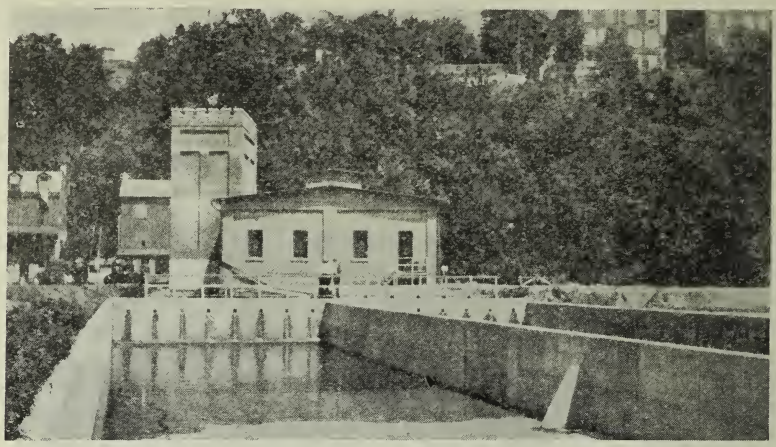
The screenings are removed from the screens by traveling brushes and disposed of in an incinerater.

The sewage is then passed through a grit chamber and into the electrical unit for treatment, the flow being measured by a Venturi meter. Each electric unit consists of an airtight chamber having a length of 28 feet, and a depth of 20 inches. This chamber contains the electrolytic plates by which the sewage

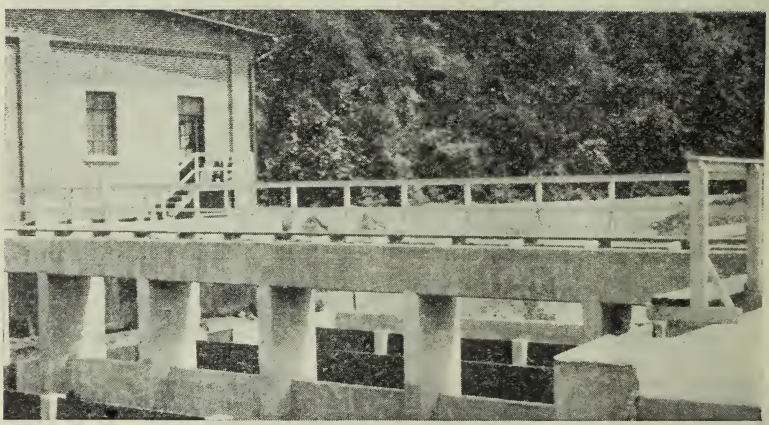
Electrolytic Plant, Allentown

is subjected to electrical action. Into these chambers is introduced 700 to 1,000 pounds of lime (Cal. Oxide) per million gallons per day.

The effluent will be discharged into concrete settling tanks, from which the sludge will be drawn to sand drying beds and the clarified effluent run into the creek.



Settling Tanks, Allentown



The operation of this plant will require 126 K. W. hours per million gallons per day, and the cost of power is 2c per K. W. H. The cost of lime is $8.30 per ton. The power required for operation of the mechanical units of the plant is as follows:

½ horse power for lime feeder.

½ horse power per million gallons daily for screens.

1 H. P. for water pump to mix lime.

1,500 watts for paddles per million gallons daily=1½ K. W.

1-25 H. P. motor used about 3 hours daily for pulverizing lime, 2½ K. W. per million gallons daily.

The total cost of this plant was $205,000.00 without any sewers, of which $134,576.00 was paid to the Landreth Co. for machinery and labor.

The screenings are estimated at four cubic feet per million gallons per day, and will contain 95% moisture.

This plant was finished on June 1st, 1921.

CHAPTER 3.
Phillipsburg, Pa.

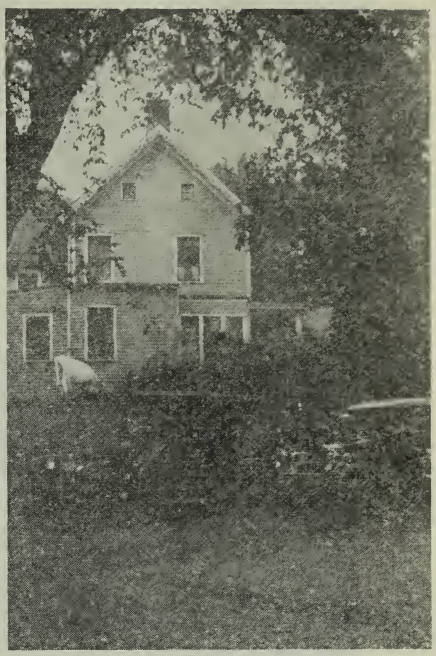
Phillipsburg has a population of 20,000 with 17,000 now served. Character of sewage, 15% sanitary and 85% industrial.

Average daily volume is 500,000 gallons Maximum daily volume is 800,000 gallons. Minimum daily volume is 200,000 gallons.

The plant is a duplicate of the Allentown plant. On the day of my visit, July 20, 1921, only one electric unit was in operation and the meters indicated 72 volts, 33 amperes and 1,300 watts.

No data was available regarding suspended matter excepting a report of October 19, 1920, which gave the average daily volume of inflow of 52.9 ppm and 44.2 ppm in the effluent. It was stated that the sludge would have a weight of 1,508 pounds per million gallons dry basis, and 8,880 pounds per million gallons on wet basis.

The sewage as it entered the plant looked about like pure water with only a trace of fecal matter. After treatment in the units the grease and oil scum was very apparent and was intercepted by barrels and diverted to coke beds.



Buildings Adjacent to Plant

The effluent as it entered the settling tanks was muddy, and after being detained in the settling basins for four hours overflowed the weir like clear water and was discharged into an adjoining creek. The dried sludge resembled clay and was used for filling on land.

Sewage Plant, Phillipsburg

There was practically no odor connected with the plant, which is located adjoining several houses.

The cost and amount of electricity for this plant is substantially as given for the Allentown plant except that electricity is 3 cents per K. W. hour and lime $10.90 a ton.

Mr. C. P. Landreth stated that he has no interest in the method or amount of treatment given to the effluent or sludge beyond his electric units.

This Landreth Process has also been used at Elmhurst, N. Y., where one million gallons daily are treated. An experimental plant of one million gallons daily was also in operation in 1918 in Easton, Pa., but later dismantled.

CHAPTER 4.
Plainfield, N. J.

The Plainfield plant treats sewage from Plainfield, North Plainfield and Dunellen.

The total population tributary is 35,000, and the flow is 3,300,000 gallons per day.

This plant consists of fine screens, Imhoff tanks, sprinkling filters, secondary tanks and sludge beds. Taylor nozzles are used in the filter beds which have a depth of six feet.

The filters are of 1½-inch crushed rock. The final effluent contains about 30 ppm of suspended solids and is run into an adjacent creek.

A 10-foot diameter Reinsch-Wurl screen was installed in 1918.

The sludge was spread on lowlands and plowed under.

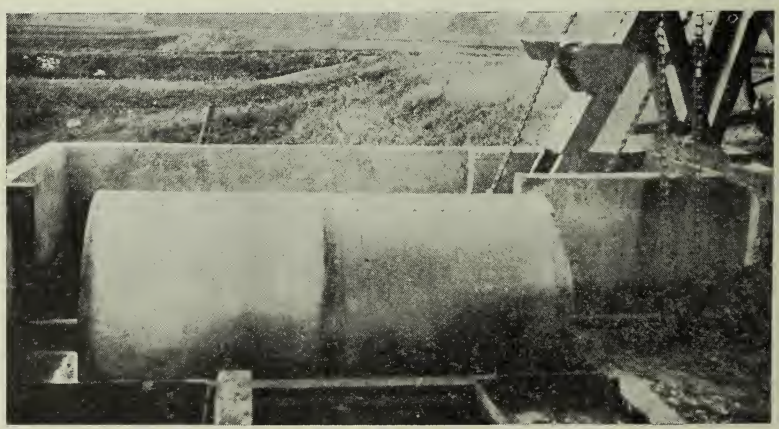
A slight odor was noticeable around the plant.

Sprinkling Filters, Plainfield

CHAPTER 5.
New Britain, Conn.

The population is 55,000, of which 44,000 are served.

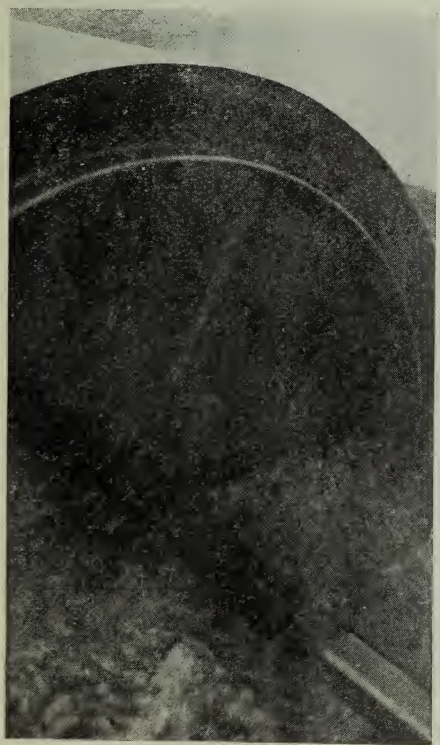
Sewage consists of domestic and industrial and is delivered through an outfall four miles long.



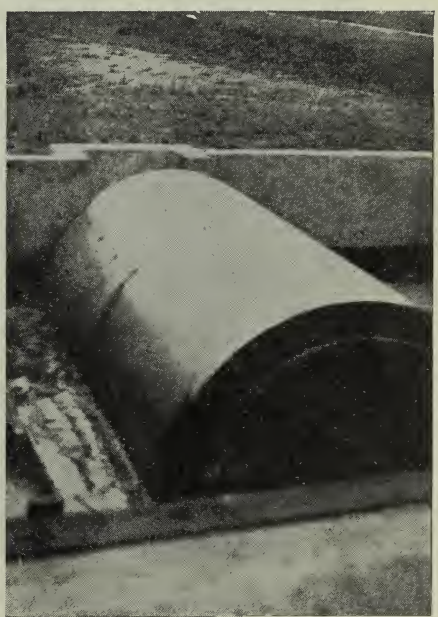
Drum Screens, New Britain

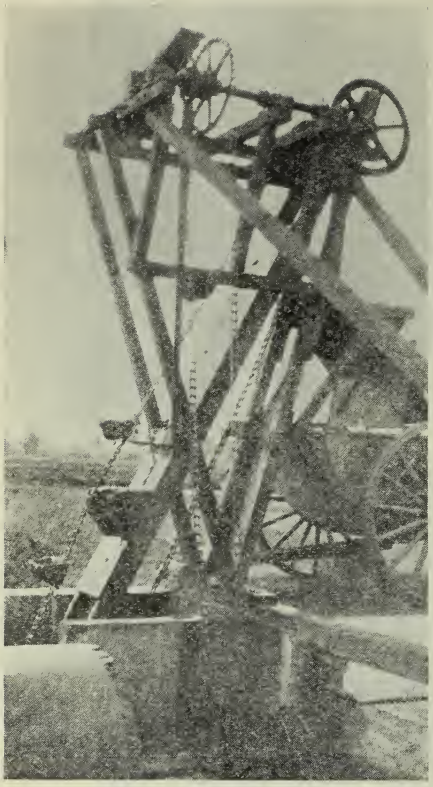
Its average daily volume is 4,000,000 gallons.
Its maximum daily volume is 6,000,000 gallons.
Its minimum daily volume is 1,200,000 gallons.

The sewage contains an average of 110 ppm of suspended matter, of which 20% is removed by a fine screen having 1/16" x ½" slots, the percentage of openings being 24.6%. The length of the screen is 8 feet; its diameter is 4 feet 10 inches (the same as proposed at East San Pedro). It revolves at the rate of 22 RPM or 330 feet surface speed per minute. This operation required 1.56 h. p. A 3 h. p. motor is used. 2 h. p. thereof being required for the conveyor for screening and screen and 1 h. p. held in reserve.



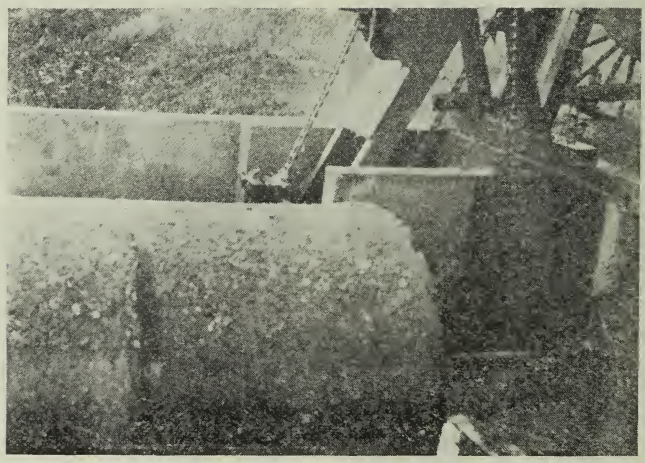
Drum Screens, New Britain



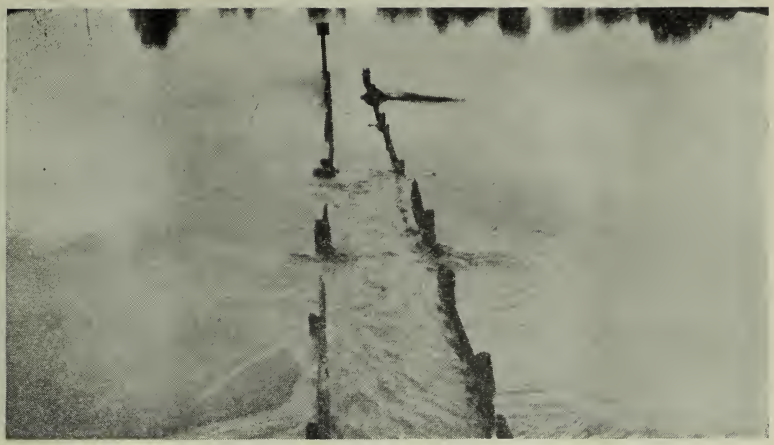


Screening Elevator, New Britain

Screening Elevator, New Britain



Screening Elevator, New Britain



Sewage Discharge on Filter, New Britain

This screen was run for 7 days without stopping and tests made by me show no clogging.

The screenings average 32 cu. ft. per mil. gals. and contain 85% moisture, which is equivalent to 330 lbs. (dry weight) per mil. gals.

At the time the photographs were taken 4½ mil. gals. per day were passing the screen.

The plant was built in March, 1921. The effluent from the screen is discharged onto filter beds having an area of 37 acres which are 6′ deep of sand and gravel in clay pits. They are subdrained into the Mattabesset River.

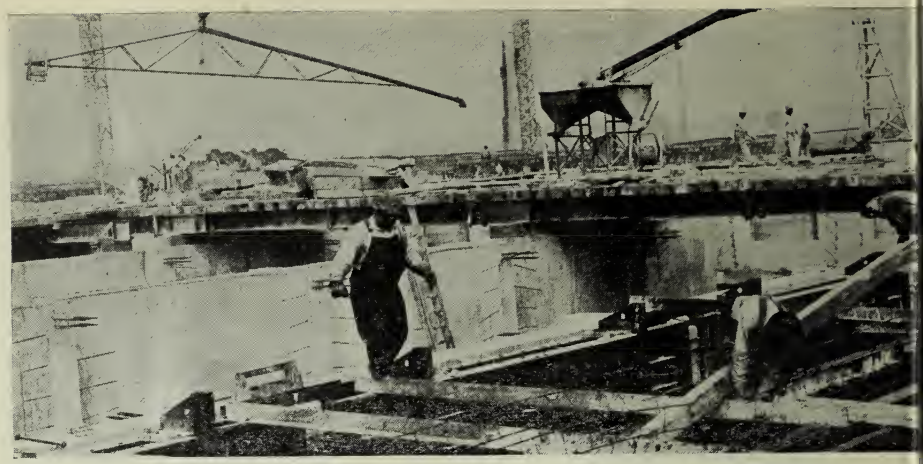
Diversion Chamber, New Britain

CHAPTER 6

Boston, Mass.

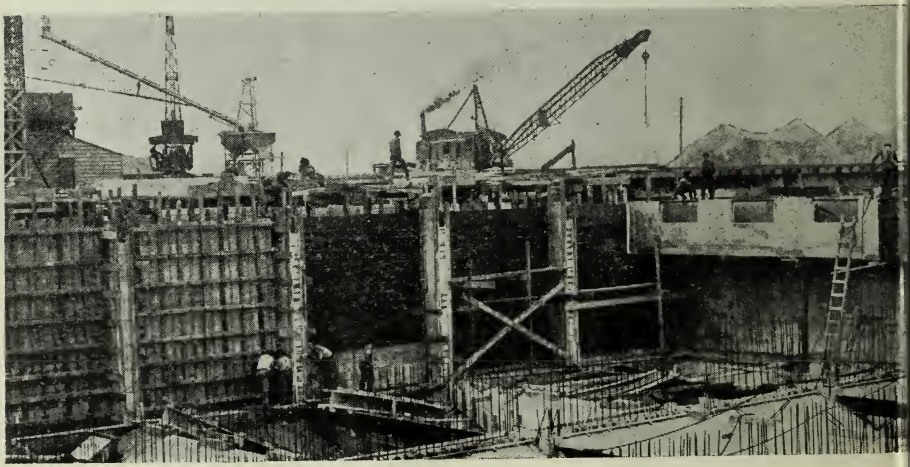
Boston and adjoining cities dispose of their sewage through three outfalls. The north side at Deer Island, the City proper at Moon Island, and the south side at Nut Island.

At Deer Island the average daily volume is 70 million gallons.

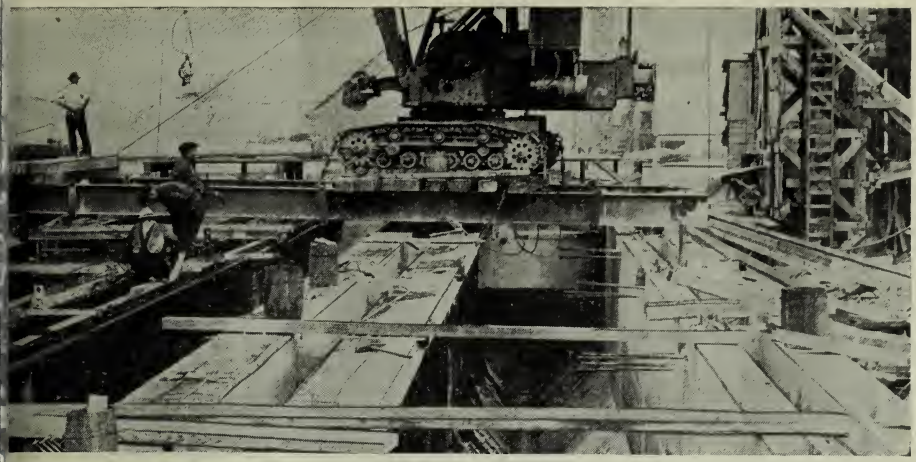


Baffle Walls of Settling Tank

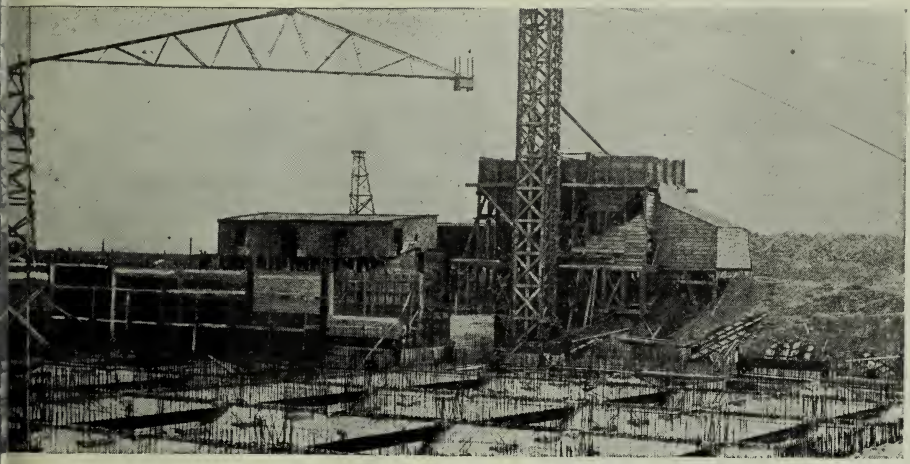
Walls and Channels of Settling T



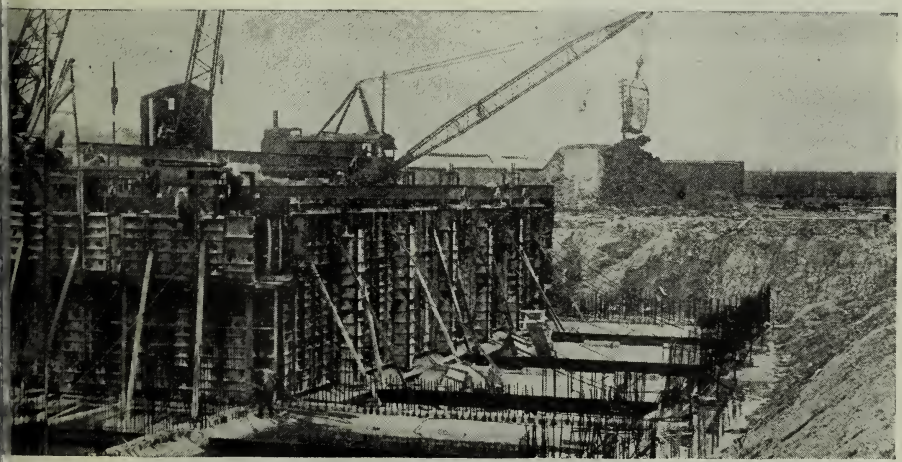
Settling Tanks, Calu



et Treatment Plant, Chicago

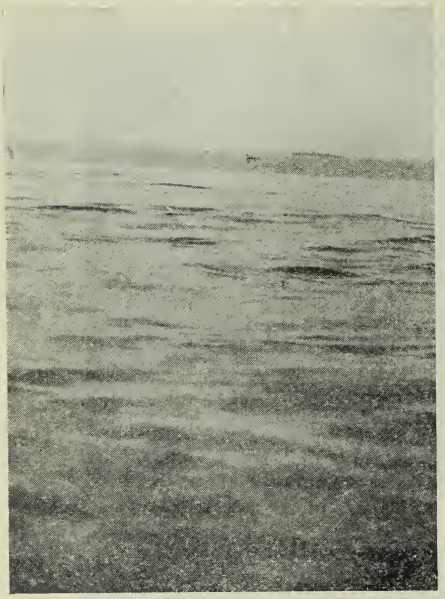


lumet Treatment Plant, Chicago



ment Plant, Chicago

Moon Island, Boston



Deer Island Outlet, Boston

Moon Island Outlet, Boston

At Moon Island the average daily volume is 100 million gallons.

At Nut Island the average daily volume is 65 million gallons.

An inspection by boat of each of these outlets was made and photos taken of the discharge of sewage.

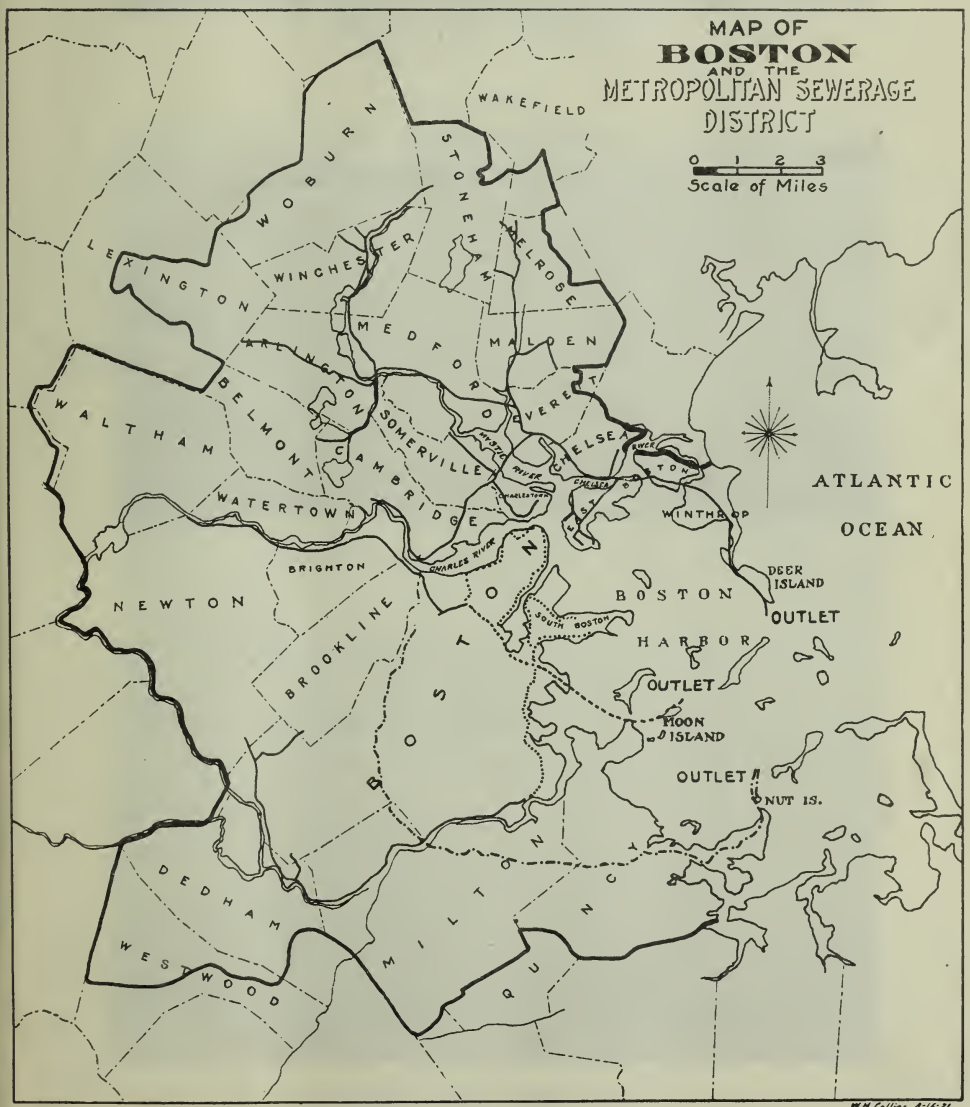
At Deer Island no odor was noticeable, while the field was well marked. The depth of water over the end of this outfall is 50 ft.

At Moon Island, where the sewage is stored until 1 hr. after high tide before it is discharged, the odor was more pronounced, due to surface discharge.

At Nut Island surface conditions were indentical with those at Deer Island, the depth of the water over the sewer outlet being about 30 ft.

The Moon Island outfall was placed in operation on January 1, 1884.

The Deer Island outfall was laid in 1891, but extended in 1918, while the Nut Island outfall was completed in 1901.



Moon Island Outlet, Boston

Nut Island Outlet, Boston

Deer Island Outlet, Boston

Sludge Beds, Fitchburg

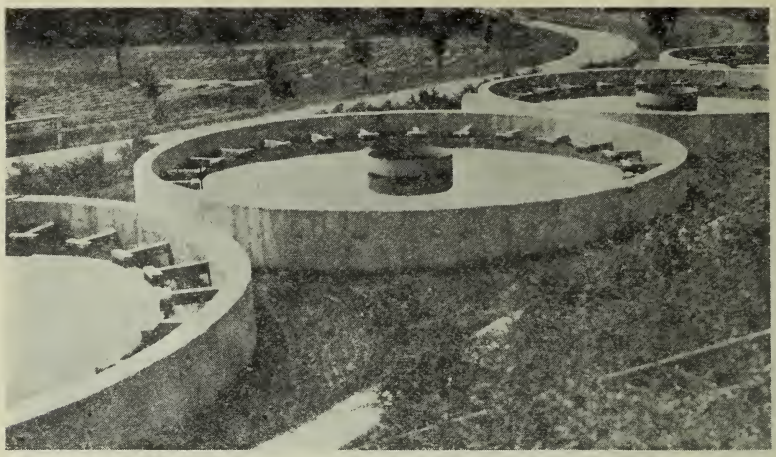
CHAPTER 7

Fitchburg, Mass.

Fitchburg has a population of 41,000, of which 37,000 are now served. The sewage is domestic and the system is on a separate basis. The average daily volume is 3,000,000 gal. and the maximum 6,500,000 gallons. The sewage is treated as follows: Coarse screens, grit chambers, 5 Imhoff tanks, dosing chamber, sprinkling filters, followed by secondary tanks. The sludge is dried on sand beds and removed after an average of three weeks drying to be used for filling low land areas, with an occasional sale to farmers at 25c per load. The demand for sludge is practically nil. The final effluent is dis-

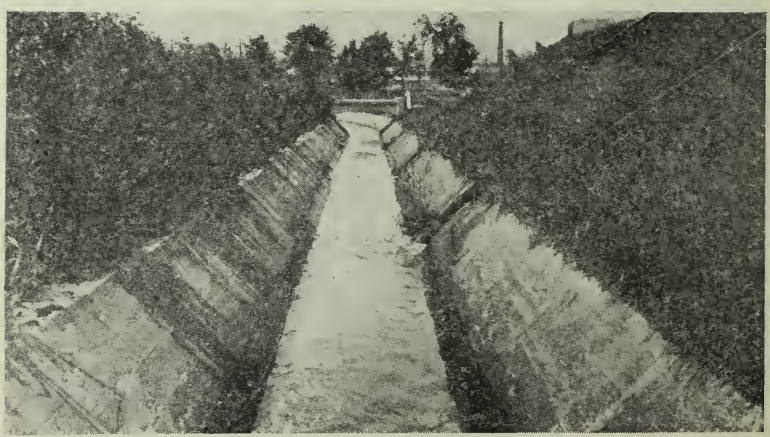
Sludge Beds, Fitchburg

charged into an adjacent creek. The plant has been in operation since 1914. The detention period of flow through the tanks is 10 to 12 hrs. The thickness of the partition walls is two inches. The sand filters cover two and one-tenth acres and are 10 ft. deep and permit the handling of sewage at the rate of 30,000 persons per acre. The Gault (Worcester) nozzles are used, and spaced 15 feet apart. The stone used varies from one to two inches. The sub drainage is made through a floor, consisting of 5″ by 1⅛″ by 17″ blocks

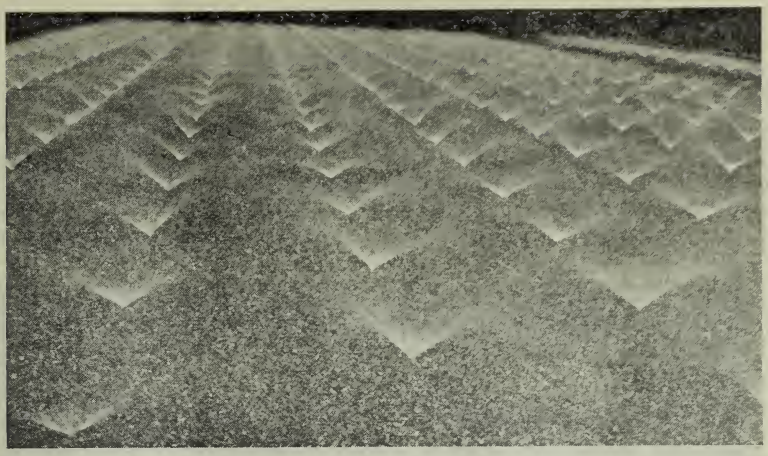


Secondary Tanks, Fitchburg

Imhoff Tanks, Fitchburg

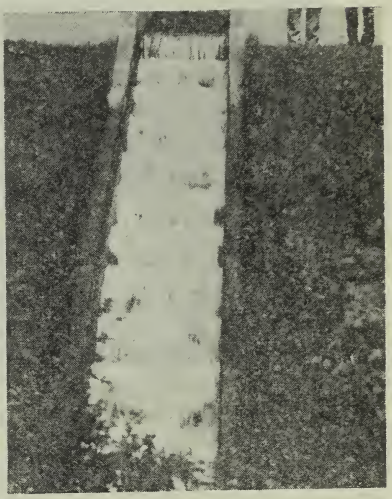


Effluent Channel, Fitchburg

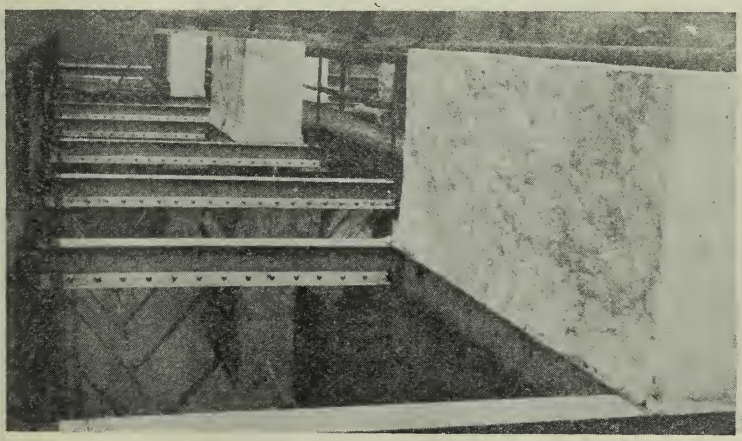


Sprinkling Filters, Fitchburg

resting on edge which gives 43 per cent air space. The sludge beds cover 43/100 acres. The Imhoff tanks remove 60 to 75 per cent of the total suspended solids and 99 per cent of settleable solids. The Hancock ejector is used to remove sludge from the tank between April and December but no scum is removed. The secondary tanks give a clear effluent which is discharged down aerating ladders. The plant cost $300,000 and the land $20,000. The treatment cost is $11.00 per million gallons or $12.00 including care of grounds. No complaint has been made of the plant and no odor was noticeable on day of visit when temperature was 80 degrees in shade.



Aerating Ladders, Fitchburg

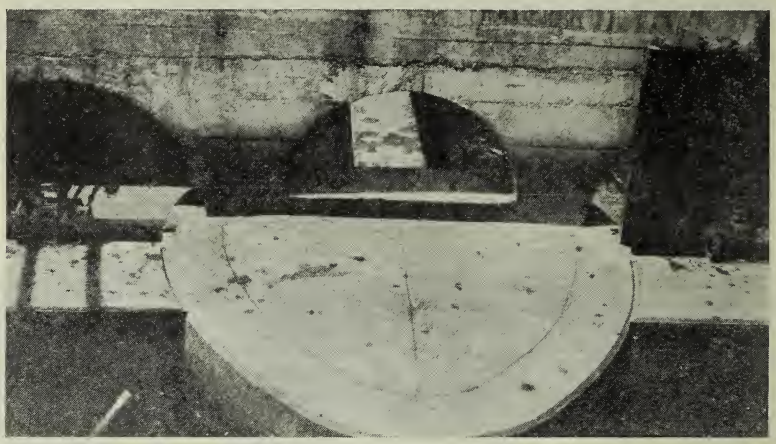


Imhoff Tanks, Fitchburg

CHAPTER 8

Worcester, Mass.

The population is 180,000, of which 170,000 is served. The system is a combined one, the average daily volume is 18 million gallons, the maximum 54 million gallons and the minimum 12 million gallons. Thirty-eight per cent of the sewer mileage is a combined system, but the total flow consists of domestic, industrial and manufacturing waste from wire mills, carpet works, dye works and tanneries. The present treatment plant consists of two grit

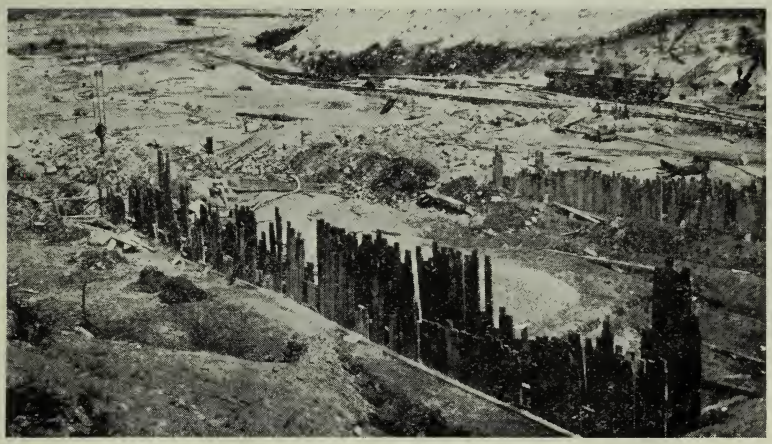


Grit Chamber, Worcester

chambers followed by the addition of 625 lbs. of lime per million gallons to the raw sewage, after which this flow is discharged into settling basins. The grit chambers are 40 ft. long, 10 ft. wide and 8 ft. deep and remove 0.10 cu. yds. of grit per million gallons. These chambers are cleaned by hand rakes, the cost of cleaning being $1.95 per cu. yd. When clam shell removal is made, the cost is 85 cents per cu. yd. This chemical treatment is made for only seven hours each day, 8:30 a. m. to 3:30 p. m., and during the remainder of the twenty-four hours the sewage is by-passed to the filter beds which cover 72 acres and are 5 ft. deep. These filter beds contain sand overlying

Sewage Plant, Worcester

a system of 6″ sub drains spaced 25 ft. to 33 ft. apart. The sand filter effluent shows a removal of 85% organic matter and 95% bacteria. These filters provide for 60,000 gallons per acre per day and the under drains should be relaid at least every five years. Effluent from these filters contain considerable iron. Sludge from the settling tanks amounts to 3500 gallons, 96% moisture, per million gallons of sewage treated and is pumped to drying beds. Lime used cost $14.20 per ton and the treatment costs $9.00 per million gallons, which includes the sludge disposal There is no demand for sludge fertilizer. Owing to complaint from property owners and others on the Blackstone River below the Worcester plant, the City of Worcester is now constructing a new treatment plant consisting of twenty-two Imhoff tanks, 36 ft. wide and 90 ft. long which in 1934 are expected to treat 25 million gallons per day, and in 1950, 60 million gallons per day. The Imhoff tank effluent will be further treated on 14 acres of trickling filters 9 ft. deep. This new plant is planned to be ready for use in April, 1924, and its cost is estimated at $2,500,000.00.

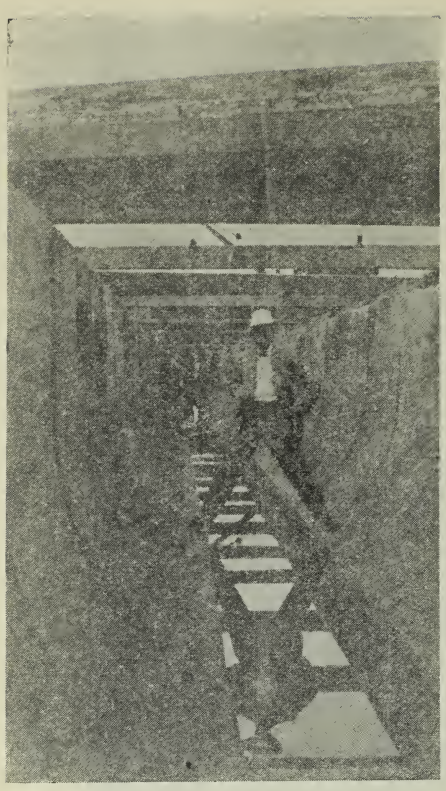


Site for New Plant, Worcester

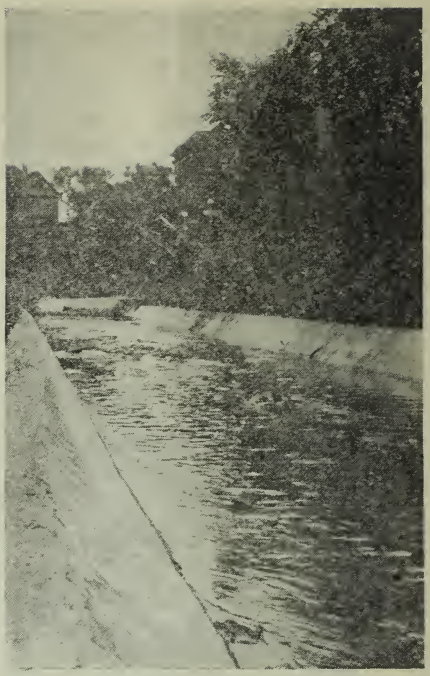
CHAPTER 9

Syracuse, N. Y.

Syracuse has a population of 171,717 all of which are served. The sewage is domestic and combined. The flow averages 125 gallons per capita, has a minimum daily volume of 15 to 18 million gallons and an average daily flow of 27 million gallons, including storm water. There are 250 p. p. m. of suspended matter in the average daily flow. At the present time this city is building a 90″ intercepting sewer and has planned a treatment plant consisting of an overflow chamber, screen house, grit chamber, pump house and four Dorr tanks. These tanks are to be 100 ft. diameter and have a depth of 7 ft. at sides and 9 ft. in center. The detention period is to be three-quarters of an hour, which will cause 60% of the suspended matter to be removed. The effluent from the tanks is to be discharged 1400 ft. out into Onondaga Lake from which no water supply is taken. The sludge is all wasted on beds on which is discharged waste from the Solway process. This waste is forty times the amount of sludge and four times greater than the amount necessary for sludge disposal. This plant will have a maximum capacity of 55 million gallons per day and all volume above this amount will be by-passed into the lake. The outfall sewer is 60″ in diameter and has four 24″ outlets 24 ft. apart with an open discharge at its end where it is 25 ft. below the water surface in the lake. The proposed plant was designed after



Outfall Sewer, Syracuse



Drainage Cannel, Syracuse

tests had been made of different kinds of treatment of the flow under the existing conditions for over a period of one year. During this time an experimental tank was installed to get the effect of both storage and detention under varying conditions. This tank was 100 ft. long, 30″ wide and 48″ deep, with an additional depth of 24″ for sludge. The cost of the outfall sewer and plant is estimated at $800,000.00.

Irondequoit Plant, Imhoff Tanks, Rochester

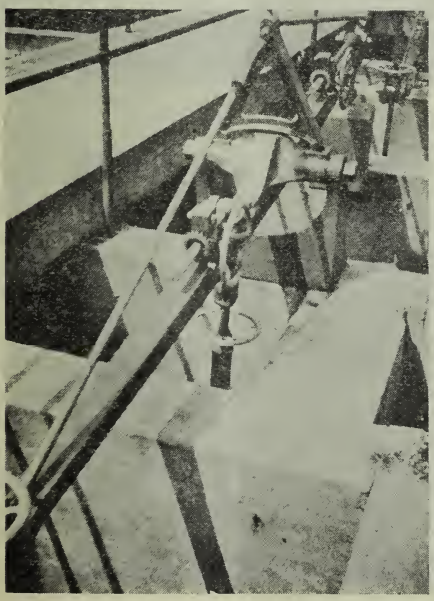
CHAPTER 10

Rochester, N. Y.

Rochester has a population of 300,000 and is all sewered. The city is divided into three sanitary districts known as the Charlotte, Irondequoit and Brighton. The Charlotte plant will treat sewage of 1200 population and has just been completed. This plant consists of bar screens, grit chambers and one circular Imhoff tank. The screen consists of 2″x½″ bars spaced ¾ of an inch. The grit chamber is 40 ft. long. The Imhoff tank has sludge capacity at the rate of 1 and 6/10 cu. ft. per capita. The gate valves are operated by 3 Nash compressors, size No. 1, under 15 pounds pressure. The sludge is dried on circular sludge beds surrounding the Imhoff tanks and can be bypassed into the outfall sewer.

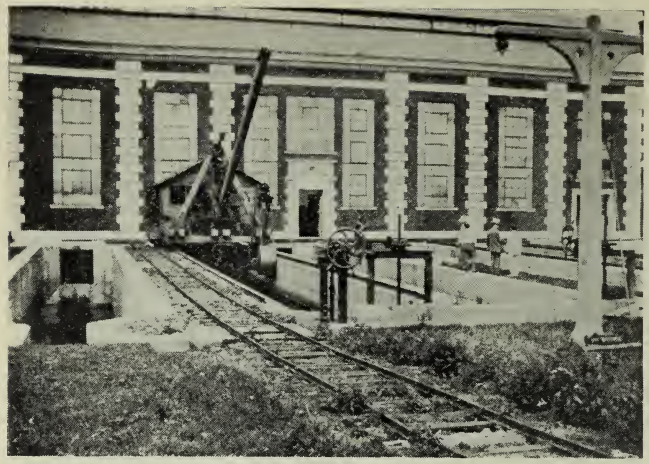
The Irondequoit plant was placed in use in 1917 and treats 32 and 6/10 million gallons per day, which volume contains 324 parts per million of suspended matter. This plant covers 31 and 5/10 acres and consists of bar screens, 6 grit chambers, 4 Reinsch-Würl screens—Imhoff tanks and sludge beds. The tank effluent is discharged into Lake Ontario. The grit chambers

Charlotte Plant, Rochester



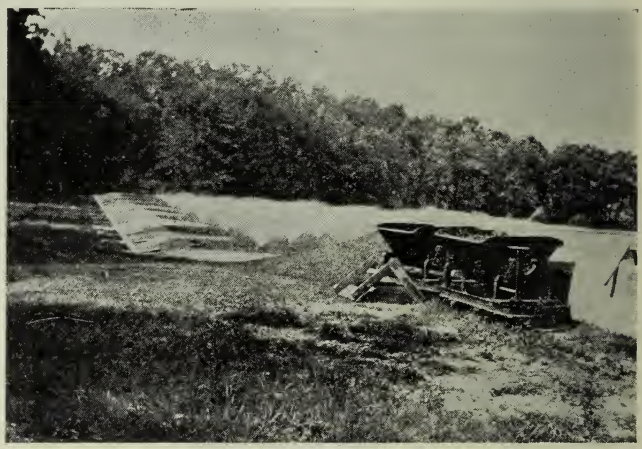
Charlotte Plant, Gate Valves, Rochester

are 90 ft. long and 10 ft. wide and remove one and one-eighth cu. yds. of grit per million gallons. The sewage has a velocity of flow through these chambers at the rate of 9/10 of a foot per second; at the time of my visit but one chamber was in operation. The sewage is a combined flow varying from 20 to 80 million gallons per day. The Reinsch-Wurl screen has a slope of 30 degrees from the horizontal, which is too steep for effective removal, one screen has ⅜″ slots and another ″⅛ and two others one-sixteenth inch, the slot length being 2″ in all cases. The first two screens mentioned are used for normal daily flow and the latter for storm flows. These screens remove 6 cu. ft. per million gallons and cost when they were originally placed, $54,000 which included the bridging and electrical work. The screens show

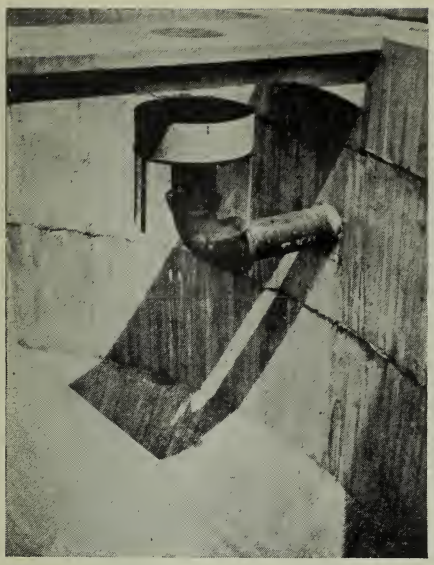


Irondequoit Plant Grit Chambers, Rochester

Brighton Plant Sprinkling Filters, Rochester



Brighton Plant, Rochester



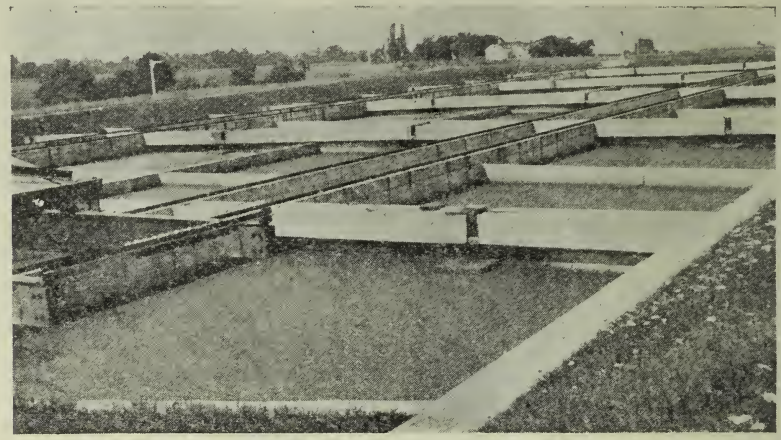
Charlotte Plant, Rochester

marked signs of wear and required replacement after being in use 560 days. The brushes are replaced every two years. There are five double Imhoff tank units and the flow into these units is regulated by forty Hydraulic gate valves. These tank units are 62 ft. long and 24 ft. wide and the flow has a velocity of one ft. per second. The tanks remove about 43% of suspended solids and 71% of settleable solids, there being about 300 parts per million in the influent. At the time of my visit there was 3 inches of scum in the tanks and no scum had been removed since March. The age of sewage reaching the plant varies from one to 12 hours. The sludge averages 1.08 cu. yds. per million gallons and is removed from the drying beds every thirteen days and sold at 75c per load or 50c per cu. yd. When drawn off from the tanks the sludge contains from 79 to 86% moisture and when removed from sludge beds 50 to 65%. The cost of this plant was $1,000,000, and in 1920 it cost $30,000 to operate. There are employed at the plant, one superintendent, one chemist and assistant, and two laborers on 8 hr. basis. At the tanks there are one foreman and twelve laborers.

The Brighton plant was placed in use on March 1st, 1916, and has an average daily volume of one to one and a half million gallons. The sewers are built on a separate system. The plant consists of grit chambers, Imhoff tanks, sludge beds, 1 acre of sprinkling filters and final settling basins. The

Brighton Plant, Rochester

filters contain one inch and two inch stone and are six feet deep. Six-inch sub drains are used, the nozzles are Columbus type and spaced 14 ft. in triangles. The final effluent has a stability of more than 10 days and there is a removal of 80% of suspended solids. The cost of this plant was $118,000,



Irondequoit Plant, Sludge Beds, Rochester

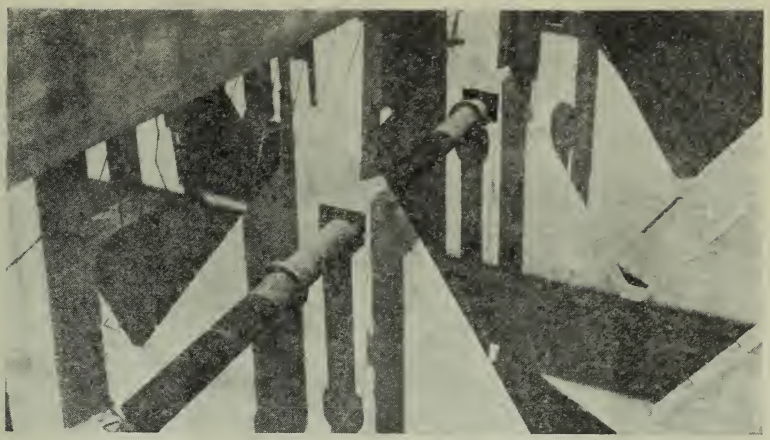
plus $2,000 for laboratory or a total of $120,000. The fall of 75 ft. from the head chamber to the plant provides for the electricity for the plant, there being 21 horsepower for each six second ft. of sewage flow. This plant uses three men for operation. The Imhoff sludge amounts to 540 cu. yds. per year.

CHAPTER 11

Cleveland, Ohio

Cleveland has a population of 800,000, of which 90 to 95% is served. The sewage is combined and contains 250 parts per million of suspended matter. The daily volume to be treated is 125 gallons per capita. There are four sanitary districts—westerly, easterly, southerly and a low level section; 40% of the sewage of the city is discharged into the Cuyahoga River,thence into Lake Erie, so that this river is very black and septic. The Westerly plant is under construction and consists of coarse screens, grit chambers and Imhoff tanks. The tank effluent is to be discharged into the lake through a submerged outfall of the multiple outlet type, at a depth of about 30 ft. and about ½ mile from shore. It is proposed to dump the tank sludge into the

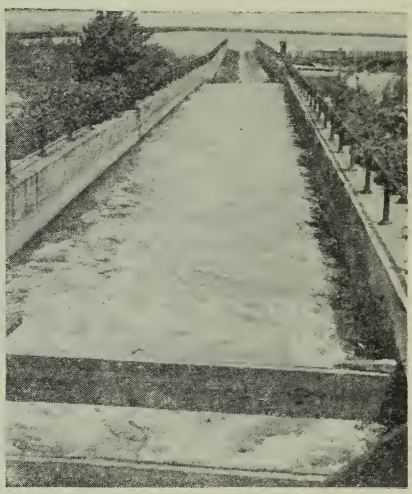
Westerly Plant, Cleveland



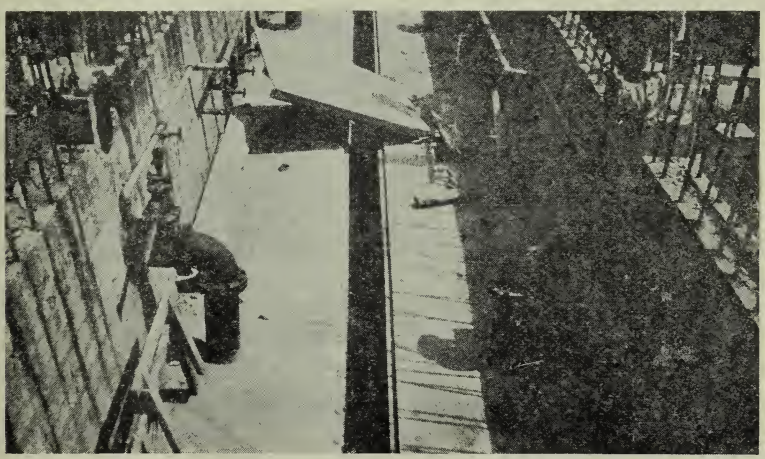
Westerly Plant, Imhoff Tanks, Cleveland

lake by barges. The estimated cost of this plant is $1,100,000. This plant is within a half mile of a popular bathing beach. At the present time the sewage is discharged after dosing with 6 parts per million of chlorine, into the lake at a distance of 1400 ft.

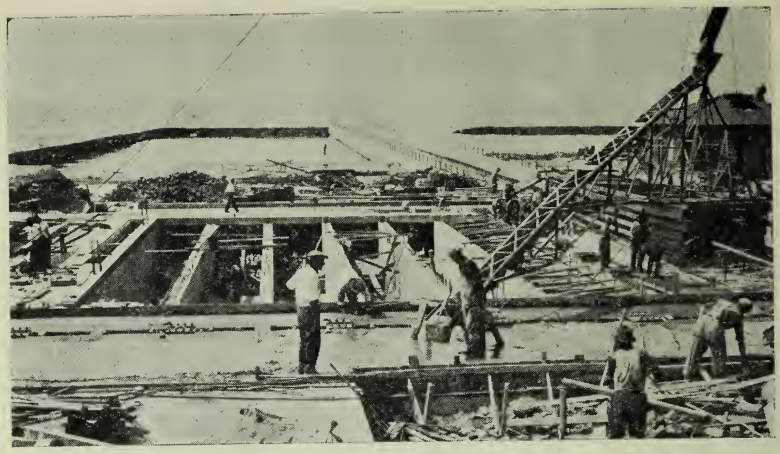
The Easterly plant is under construction and consists of parallel grit chambers, each with its own bar screen, and an open outfall into Lake Erie. Raw sewage averaging 52 million gallons per day is now dis-



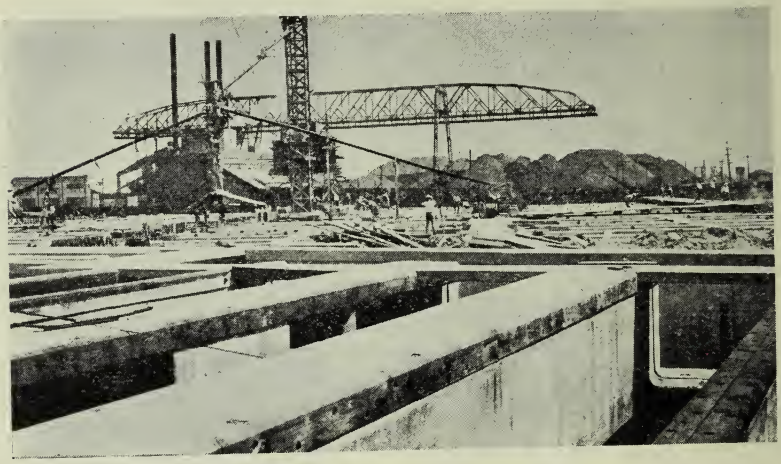
Westerly Plant Outfall Sewer, Cleveland



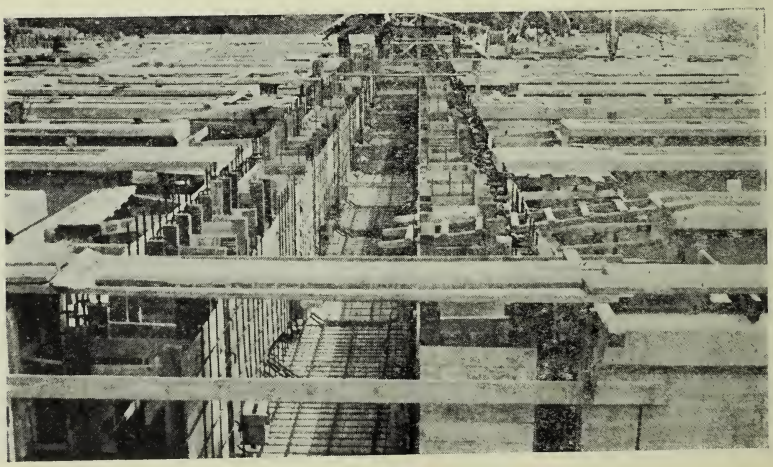
Westerly Plant, Imhoff Tanks



Easterly Plant, Grit Chambers and Outfall, Cleveland



Westerly Plant, Cleveland



Westerly Plant, Imhoff Tanks, Cleveland

charged into the lake 400 ft. off shore. Bathers use the beach within one hundred yds. of the plant and floating solids along the beach are very noticeable. There is no complaint, althoug odors from the outfall are very strong. Within 200 yds. of this plant are high-class residences. The cost of this plant is estimated at $1,250,000.

The Southerly plant is not as yet built.

CHAPTER 12

Detroit, Mich.

Detroit has a population of 950,000, and including Highland Park, Hamtranck, Brownly and Charbereau, over a million.

There are approximately 81 sq. miles within the city limits. About five years ago work was begun on the construction of a combined sewerage system, discharging into the Detroit River, with a proposed treatment plant for the sanitary sewage, consisting of grit chamber, Imhoff tanks, and possibly chlorination. The site for this plant has been bought but no work done as yet.

The City is now building 9′ and 11′ intercepting sewers at the rate of two miles per week costing $1,000,000.00 per month, out of an available fund of $33,000,000.00, $25,000,000.00 of which was obtained by bond issue in August, 1920.

Most of the work is built by contract, although some is by the city.

In 1970 it is estimated that the ultimate population will be 2,664,000 when the maximum flow per day will be 879 million gallons and the average 493 million gallons, which is an average of 185 gallons per capita.

The design used for the intercepting sewer was an average of 114 gallons per day per acre, the maximum being double the average.

The average sewage flow in 1920 was 177 gallons per capita, the maximum being 287 gallons per capita.

No infiltration is expected.

The proposed treatment of the sanitary sewage will remove 90 to 95% of both settleable solids and suspended matter, the percentage of suspended matter varying with the flow per capita.

In the past this city has had trouble with large amounts of gas and oil in its sewers, and at times explosions have occurred on this account. It is not expected, however, that oil in Imhoff tanks will interfere unless over 1½″ thick.

The cost of the proposed treatment by Imhoff tanks is estimated between $6 and $6.50 per million gallons, whereas if activated sludge process were used it would cost $15 per million gallons.

Electricity cost is from 1 to 1⅓ cents per K. W. H.

It is proposed to use 5 parts per million of chlorine costing $.025 per lb. At present time the flow in Detroit River is 210,000 second feet.

In the neighboring city of Pontiac, Mich., which has a population of 52,000 and a sewage flow of 100 gallons per capita, a sprinkling filter plant has been in use for a year. The sewage has an average detention period of 2½ hours, and 94-96% of the settleable solids are removed.

CHAPTER 13

Toledo, Ohio

Toledo has a population of 243,000, all of which is served. The sewage is combined. Including the sewage of towns adjacent, which will in time be treated at the site proposed for sewage disposal, the total sewered popula-

tion will be 300,000. Intercepting sewers have been planned for which $1,500,000 are now being spent for construction. Toledo has bonded itself for $2,800,000.00 so that a balance is left for future work.

No sewage treatment is proposed at present time as conditions are such that proper dispersion of sewage into the Maumee River will enable sufficient dilution for several years.

CHAPTER 14
Lima, Ohio

Lima has a population of 41,000. Intercepting sewers are being constructed to eliminate the discharge of raw sewage into Hog Creek, a stream which flows across the city and which is in a very insanitary and septic condition. The sewers are for combined flow and vary from 3′6″ at upper end to 7′ at outlet.

In two sections visited, segment block (Robinson type) was used, and 25 bbls. of cement costing $2.50 per bbl. were required per 100 lin. ft. of 6′ 6″ sewer. Very little sheeting was used and trench in hard clay readily cut to required shape. A force of 2 masons on invert, 1 mason on arch, and 19 laborers was employed. Masons are paid $8.00 to $14.00, and labor from 35 cents to 58 cents. Trenching machine on 4′ 6″ sewer averaged 70 lin. ft. per 8 hrs. in 21′ depth. In 18′ cut, 6′ 6″ sewer averaged 30-40 ft. per day, and with no water 6′ 6″ sewers in 20′ cut averaged 60 lin. ft., whereas 4′ 6″ sewers averaged 80 lin. ft.

Prices paid for the Robinson segment block in August, 1919 f. o. b. job:

36″	$2.44	66″	$6.00
42″	2.99	72″	6.84
54″	4.22	78″	7.46
60″	5.59	84″	9.35

CHAPTER 15
Columbus, Ohio

Columbus has a population of 237,000, 80% of which is sewered. One-half of the city is on the combined system and one-half on the separate.

The average daily flow is 26 million gallons, which is treated by a plant consisting of 22 Imhoff tanks 135′ long and 25′ deep. Sewage is dried on 8 open beds in about ten days, and then hauled to dump by gasoline locomo-

Imhoff Tanks, Columbus

tives. The tank effluent is discharged from a head of 8 feet onto 10 acres of sprinkling filters 5½′ deep consisting of broken limestone. The nozzles are 15′ apart, 1″ to 3″ in diameter. The filter effluent passes through final settling basins into the Scioto River.

The raw sewage contains 223 P. P. M. of suspended matter, 60% being removed by tanks which remove 95% of settleable solids.

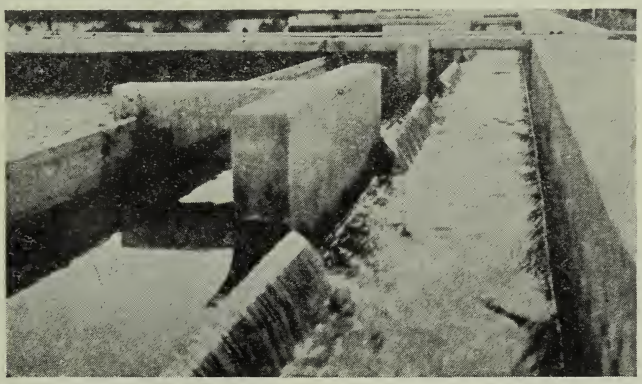
The total area owned by the city for treatment is 270 acres.

At present time the flow in the river is less than 5 million gallons daily, but the nearest town down stream is 25 miles distant.

The plant has been in use since 1916, and the filter operates about 75% of the 24 hours each day.

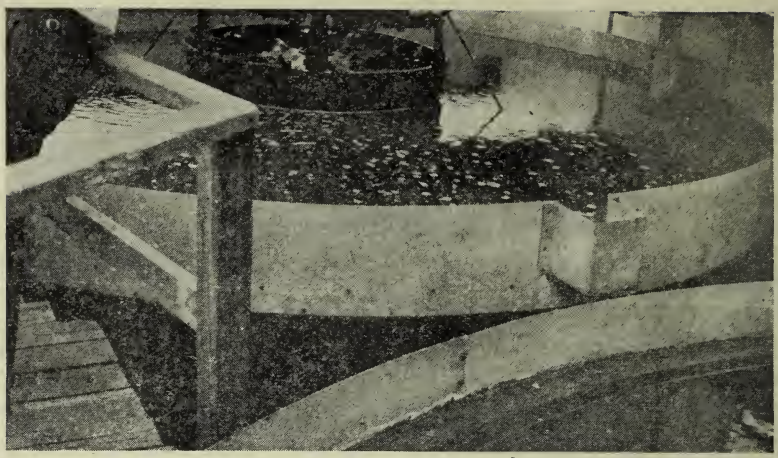
Odors at the plant were not strong and came from the sludge beds, which have not sufficient area, as 1.25 sq. ft. per capita should have been used in design rather than 0.44 sq. ft.

The operation of the plant requires 1 foreman and 5 laborers each day with a chemist and assistant.



Imhoff Tanks, Columbus

Sprinkling Filters, Columbus



Argo Plant, Chicago

CHAPTER 16

Indianapolis, Indiana

Indianapolis has a population of 314,000, of which 60,000 is not sewered. The system is a combined one. At the present time an outfall sewer discharges raw sewage into the White river, and at this location an experimental plant has been built, where the Dorr-Peck Activated treatment process is being tried.

It is planned to install a treatment plant elsewhere, and for this purpose a new outfall sewer is to be constructed which will have a maximum capacity of 55,000,000 gallons per day and an average flow of 48,000,000 gallons per day. At the end of this new outfall the sewage is to be screened through a 30-mesh drum, consisting of 12 screens, 6 feet in diameter by 7 feet 9 inches face, each of 3,000,000 to 5,000,000 gallons per day capacity. The screens will cost $28,000.

The sewage contains 250 to 300 pounds of suspended matter per million gallons.

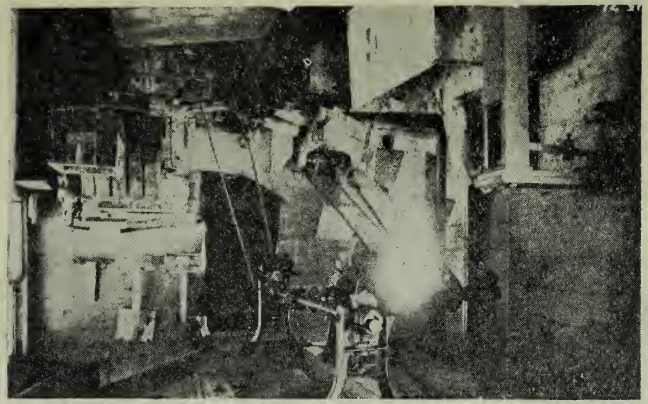
The treatment plant is to be divided into three units. The city has 200 acres of land for the eventual conditions which may be required in 1950.

CHAPTER 17

Chicago, Illinois

At the Tannery Testing Station, which has been in operation since April 1920, the tannery waste of the Griess-Pfleger Tanning Company is being treated by the activated sludge process of the Dorr type. This plant is located at the Halstead Street bridge, over the North Branch of the Chicago river, which contained considerable solid matter and oil on the day of my visit.

Two and three-quarters cubic feet of air is used per gallon of sewage treated, and the detention period is 12 hours. The Dorr tanks are 12 feet



Screening Room,

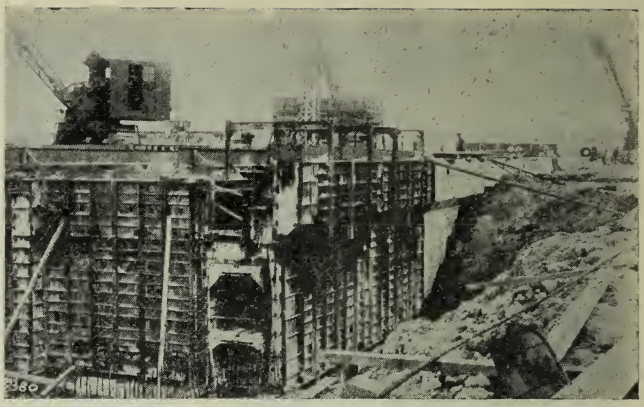
Settling Tanks and Cinder Filters,

Settling Tanks,

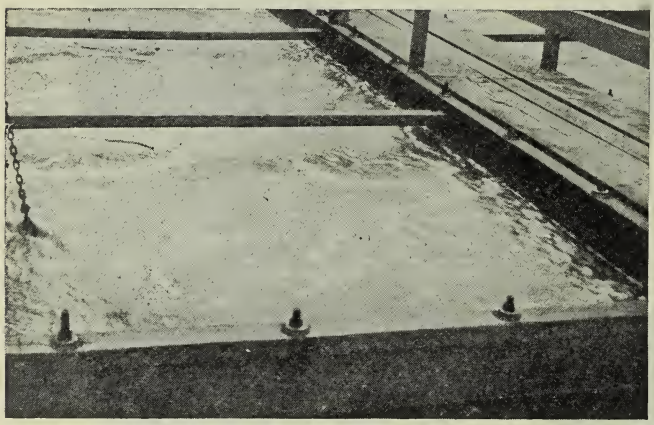
General View.

Tannery Testing Station, Chicago

deep and 12 feet in diameter, 405 gallons to be treated per square foot of surface area. 44,000 to 48,000 gallons per day are treated by the Dorr tank, and 300,000 to 400,000 gallons per acre per day are filtered though cinders and 100,000 to 200,000 gallons through sand, the effluent having a stability of 90% and more. The sand beds are 3½ feet deep and the cinder beds 5½ deep.



Wall of Settling Tanks, Calumet Treatment Plant, Chicago



Argo Plant, Chicago

In the Calumet district the population is 120,000 and plans have been made for a future population of 300,000. The intercepting sewer for this section is 17 feet in diameter, and the sewage is to be pumped, both centrifugal and impeller pumps being required.

The sewage is to be treated by a plant to cost $4,500,000 and to contain 32 Imhoff tank units, each 103 feet long, 34½ feet wide and 26 feet deep. Six 36-inch pumps and three 72-inch pumps are to be used. 300 gallons of sewage per capita is the estimated flow.

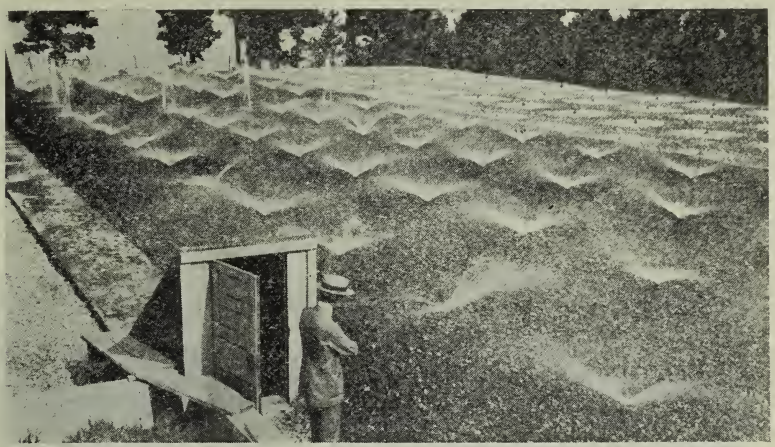
At Argo, 26 miles west of Chicago, the wastes of the corn products refinery are being treated by an experimental plant, where the activated sludge process is contrasted with the Dorr-Peck process by having the wastes treated simultaneously by each type. The latter process gives 4.2% to 6.% of nitrogen in the sludge obtained, and required 2.8 cubic feet of air per gallon of sewage treated. A 12-hour detention period is used in both cases. At the present time the plant is treating 43,000 gallons per day in three tanks each 11 feet deep, with a ratio of 1 to 5.75 between filtros plates and surface area. The suspended matter which varies from 600 to 700 parts per million is reduced to only 10 to 12 parts per million.

Sixty-five thousand bushels of corn per day are used at the Argo plant.

The flow in the Chicago drainage canal is 7000 second-feet, or approximately 2 second feet per 1000 population.

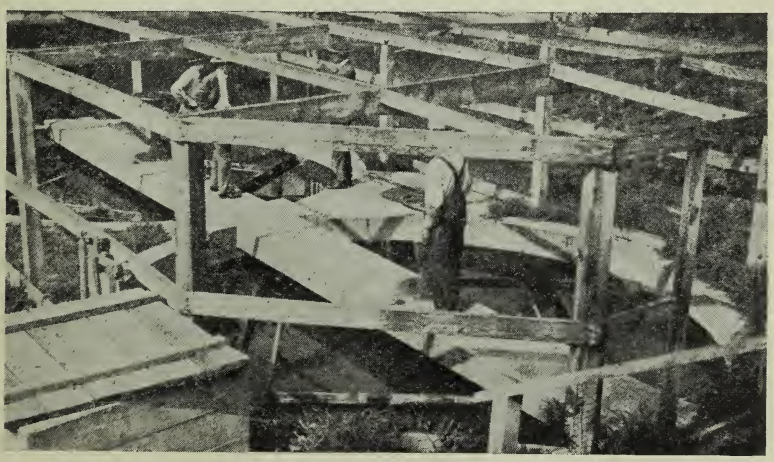
Fort Sheridan, Illinois

This plant treats the sewage of approximately 3,000 soldiers, and consists of a Doten tank and sprinkling filter 5 feet deep. The filter has under drains 12 feet apart and an area of about ½ an acre, one-half of which was in use on day of visit. The sewage is domestic and amounts to about 400,000 gallons per day. A Sanborn recorder is used to measure the flow. It was noted that some sprinklers not being in use, the head at these points was about 6 feet.



Sprinkling Filters, Fort Sheridan

There was some odor on the beds. The filter bed effluent has, however, further treatment in circular secondary tanks and then discharged into Lake Michigan, after being treated with 24 to 28 pounds of chlorine per million gallons, this being equivalent to three parts per million. Chlorine costs 8c per pound. The effluent from this plant is very clear and free from odor.



Secondary Tanks, Fort Sheridan

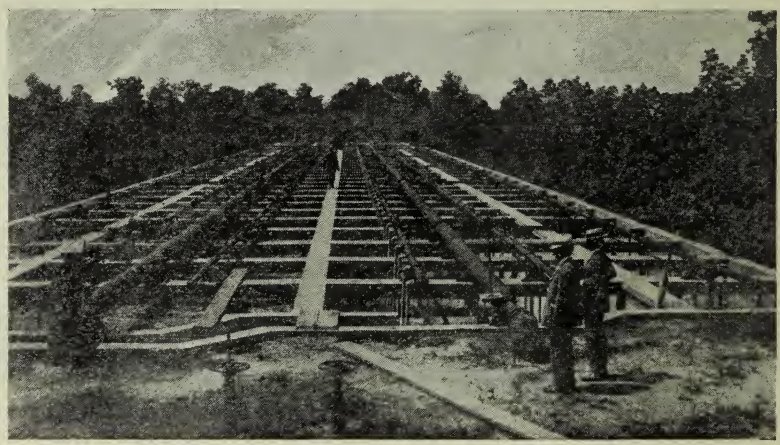
Great Lakes Naval Station

The sewage from this station is treated through a coagulating plant and then by a rapid sand filter, the beds being under drained.

On day of my visit there was considerable odor in the effluent.

CHAPTER 19
Urbana, Illinois

The population of Urbana is about 11,000. The State of Illinois is conducting in Urbana experimental studies with the sewage of the adjoining city of Champaign, which has a population of 17,000. This sewage is screened by a small Dorrco screen, having a diameter of about 4 feet and a face of 7½ inches. The daily capacity of this screen is 250,000 gallons. The slots of the screen are 1/16 of an inch by ½ an inch, are parallel to the direction of flow, and comprise 26% of the total area of the screen. The screenings amount to 85 pounds per 150,000 gallons of wet sewage and contain from 84 to 88% moisture. After screening, the sewage is carried through an activated sludge plant of the Dorr-Peck type which requires 7/10 of a cubic foot of air per gallon of sewage.



Southerly Plant, Houston

CHAPTER 20
Houston, Texas

This city has 140,000 population, 60% of which are served. The sewage is mostly separate and contains 400 parts per million of suspended solids. The sewage is pumped to two treatment plants, known as the North Side and South Side disposal plants. The method of treatment is the same at each location. The treatment plant consists of activated sludge units, having a capacity of 2,500,000 gallons per day. The North Side plant has four units and the South Side two units. Each unit consists of one main aerating channel 280 feet long, 18 feet wide and 10 feet deep, and ten sedimentation tanks about 22 feet deep. At the South Side plant the maximum flow is 8,500,000 gallons per day, the minimum 3,500,000 gallons. The average detention period is two and one-half hours, although this time varies from one and a half to three and a half hours. The filtros plates have a ratio of 1 square foot to each 7 square feet of tank surface. The South Side plant was completed

in January, 1918, at a cost of about $115,000.00 and the North Side plant was completed in May, 1917, at a cost of about $255,000.00.

The amount of sewage treated at the North Side plant averages about 75 gallons per capita, or a total of 9,000,000 gallons per day, and the effluent at this plant has a stability of 92%. 95% of the suspended solids are removed. The effluent contains an average of 4% of nitrates and 12% of ammonia. The cost of operation at the North Side plant averages $11.10 per million gallons, whereas the cost at the South Side plant is approximately $10.80 per million gallons.

The sludge may have a value of $25.00 per ton and weighs 80% of a ton per million gallons. The sludge is pressed by a Simplex press which has a pressure of 100 to 145 pounds per square inch. 113 presses being used. The sludge is dried by a Buckeye Type "A" Direct-Indirect drier which reduces the moisture to 53½%.

The Houston plants are the only ones in the United States which have been using the activated sludge method of treatment. The sludge is disposed of by lagooning, which does not create a nuisance.